

HF100H SERVICE MANUAL

This manual is established for repair•adjustment of the MinXray model *HF100H* portable x-ray unit. Copy and transfer without notice is prohibited.

Section	Contents	Page
1.0	Introduction	1
2.0	Device history	2
3.0	Specifications	3
4.0	Operating procedures	5
5.0	Pre-adjustment	7
6.0	Re-adjustment of kV	11
7.0	Re-adjustment of pre-heat time and mA	13
8.0	Re-adjustment of exposure time	16
9.0	Sample of output waveform	17
10.0	Pre-adjustment mA with/without HF Tester	18
11.0	Measure mA by mA jack output	20
12.0	Wiring diagram	21
13.0	Schematic diagram	22
14.0	Trouble - shooting guide	28
15.0	Parts list	32
16.0	Advantech Model R72/32 operator's installer's manual	Appendix 1
17.0	Collimax Collimator operator's installer's manual	Appendix 2

1.0 Introduction

This service manual is for the MinXray model *HF100H* x-ray unit.

If you have any questions or need further assistance, please contact us. We are available Monday - Friday, 8:30 - 17:00 Central Time.

Service Department
MinXray, Inc.
3611 Commercial Avenue
Northbrook, Illinois 60062-1822
U.S.A.
Tel: 1-847-564-0323
Toll free tel: 1-800-221-2245 (U.S. and Canada)
Fax: 1-847-564-9040
E-mail: [service @ minxray.com](mailto:service@minxray.com)
Internet: www.minxray.com



Always connect the power cord to a grounded AC mains electrical outlet.



High voltage is present in some internal components.



X-radiation is emitted during some calibration tests described within this manual. Observe radiation safety precautions when conducting these tests.

CARELESS OR IMPROPER USE OF X-RAY EQUIPMENT CAN BE EXTREMELY HAZARDOUS. It is imperative that this equipment be operated and serviced only by trained personnel familiar with the safety precautions required to prevent excessive exposure to primary and secondary radiation, the dangers of exposure to x-radiation, and the proper use of the equipment and instrumentation discussed in this manual. All personnel authorized to operate or service this equipment should be fully acquainted with the established maximum permissible doses, safety recommendations and procedures for working with high voltage components, and testing and calibration instrumentation.

Although this x-ray unit incorporates protective design features for limiting both the direct (primary) x-ray beam and the secondary radiation produced by this beam, design factors alone cannot prevent human carelessness, negligence, or lack of knowledge. This apparatus is sold with the understanding that the user assumes sole responsibility for radiation and electrical safety, and that MinXray, Inc., its agents and representatives, do not accept any responsibility for:

1. Injury or danger to patient or other personnel from x-ray exposure or electrical shock.
2. Overexposure due to poor operating techniques or procedures.
3. Equipment not properly serviced, installed, or maintained in accordance with operation and service manuals.
4. Equipment which has been modified or tampered with in any way.

2.0 DEVICE HISTORY

Item No.	Contents	Start S/No.
1	Pre- production	19716
2	Solder lead on the insert	21192
3	Making 8 screws lock tighter for outer case	21545
4	Fixing the nut of PCB M9110 by bond (KE42)	23232
5	Using PCB M3107-B	23232
6	Adding the labels “ Dangerous Voltage “ & “ Ionizing Radiation”	23232
7	Adding the fixing metal for insert	23539
8	Adding the fixing metal for collimator	23539
9	Changed Advantech to Collimax D-180HS-G Collimator. Modified insert case to balance Collimax D-180HS-G collimator Insert indicated in parts list No.: 11066 Unit S/No.: 25150 - 25621	25150
10	Changed Collimax collimator to Advantech R72/32 collimator Modified insert case to balance Advantech R72/32 collimator Insert indicated in parts list No.: 10695 Unit S/No.: except 25150 - 25621	26213

3.0 SPECIFICATIONS

POWER : Range ----- 100 ~ 130VAC, 200 ~ 260VAC
Minimum voltage with no load ----- 100VAC, 200VAC
Maximum voltage with no load ----- 140VAC, 280VAC
Frequency ----- 50/60Hz
Electricity consumption -----

	Minimum	Maximum
110V	16A(40kV)	30A(100kV)
220V	8A(40kV)	15A(100kV)

Maximum voltage consumption ----- 3.5kVA $\pm 10\%$



NOTE : This unit would be severely damaged if it is used with incorrect line voltage. Check the rating label on the *HF100H* for the correct input voltage for each unit.

OUTPUT : Inverter : 120 kHz high frequency inverter system with neutral ground circuit, 2 kW • 60 kHz inverter.
tube potential feedback system
tolerance $\pm 10\%$

Filament circuit : 0.5 Watt • 45 kHz inverter
tube current feedback system
tolerance $\pm 10\%$
pre-heat time : approximately 2 sec.

WARM UP TIME : Approximately 10 seconds after each exposure and after the initial Power-on.

X-RAY OUTPUT : Maximum tube voltage : 100 kV $\pm 10\%$
Minimum tube voltage : 40 kV $\pm 10\%$
kV switch : 2 kV steps
Tube current : 20 mA constant $\pm 10\%$
Timer range : 0.08 – 4.00 sec. 0.01 sec. steps
Tolerance $\pm 10\%$

X-RAY TUBE : TOSHIBA D-124S
focal spot size : 1.2 mm $\times$ 1.2 mm
target material : tungsten
angle : 16 °
anode heat storage capacity : 14kJ (20.0kHU)

COLLIMATOR : Advantech Model R72/32
Continuously adjustable light beam type with central ray indicator, and cassette size/distance indicator to aid in correct positioning.

On time : 30 sec.
Bulb : OSRM HLX-100W-12V
Illuminance : over 160 lux at 1 m SID
Contrast ratio : over 3:1 at 1 m SID

3.0 SPECIFICATIONS

FILTRATION :	inherent filtration	2.2mm Al
	collimator filtration	2.0mm Al
	total filtration	4.2mm Al
WEIGHT :	20 kgs	
SIZE :	29 cm (W) × 23.8 cm (H) × 45.5 cm (L)	
POWER CORD :	3.6 m	
EXPOSURE SWITCH :	two stage, 3.0 m	

Specifications subject to change without notice.

4.0 OPERATING PROCEDURES

CONNECTION : After confirming POWER CORD and EXPOSURE SWITCH are intact, securely connect them to main body of x-ray unit.
(If connector has lock, confirm it is locked.)
Confirm POWER SWITCH is OFF and connect POWER CORD to wall outlet or wall socket of proper mains.
(When you use an extension cord, 3.5kW should be obtained.)

POWER ON : Set POWER SWITCH on control panel to ON. Each indicator will illuminate. When the unit is warming up (WARM UP indicator is lit), exposures cannot be taken. After approx. 10 sec., WARM UP indicator will go off. The unit is now ready to use.



DO NOT SWITCH ON AND OFF QUICKLY IN A SHORT TIME. WHEN TURNING ON AGAIN AFTER TURNING OFF, WAIT FOR AT LEAST 1 MINUTE. OTHERWISE, THE HIGH FREQUENCY INVERTER CANNOT WORK PROPERLY.

kV SETTING : Set kV in the range of 40 kV to 100 kV.

TIMER SETTING : Set timer in the range of 0.08 sec. to 4.00 sec. depending on subject, distance and screen/film combination. Time increments are 0.01 sec. per step.

mA SETTING : No adjustment. Factory set at 20 mA.

SOURCE-IMAGE DISTANCE:

Use the tape measure on the side of the *HF100H* to confirm that the x-ray unit is positioned at the correct source-image distance (SID) for the view being taken.

ADJUSTMENT OF RADIATION FIELD :

Pressing the collimator switch will illuminate the field for approx. 30 sec. Adjust light field to position of radiograph by two knobs for adjustment of opening.
During this time, use the adjustment knobs to size the radiograph.

RADIOGRAPHY :

Make sure that WARM UP indicator is OFF before pressing the exposure switch.



**WARM UP INDICATOR TURNS OFF 10 SEC. AFTER POWER ON.
WARM UP INDICATOR TURNS OFF 10 SEC. AFTER EACH EXPOSURE.
IF WARM UP INDICATOR IS ON, X-RAY EXPOSURE IS IMPOSSIBLE.**

Make sure all WARNING LAMPS are off.
After all safety checks, press only first stage of EXPOSURE SWITCH. STANDBY indicator goes off after 1 sec. Then, unit is ready for exposure. Press and hold the second stage of EXPOSURE SWITCH. X-RAY indicator illuminates, the buzzer sounds, and x-ray is generated for the time set. The EXPOSURE SWITCH is a DEADMAN style. If the button is released, exposure is stopped. Press and hold the button until exposure is complete.

WARM UP indicator will light after exposure.

4.0 OPERATING PROCEDURES



NOTE : The first stage of EXPOSURE SWITCH is pre-heat of filament.
DON'T KEEP ONLY THE FIRST STAGE OF EXPOSURE SWITCH "ON" LONGER THAN 30 SEC.

POWER OFF : When the POWER SWITCH is pressed, all indicators on the control panel are off.

WARNING LAMP : *HF100H* has 2 kinds of warning lamps. If either of them is lit, x-ray cannot be generated. Each detail is as follows.

WARNING LAMP	DETAILS	COUNTERMEASURE
WARM UP	The internal circuit is warming up.	Wait until light goes off.
ERROR	Unit malfunction.	Stop procedure and follow steps below.

※ If ERROR indicator is lit even when EXPOSURE SWITCH BUTTON is released, it means an unusual situation has occurred. Turn off POWER SWITCH, wait 3 minutes, then start procedures over again. If the error indicator remains lit, refer to P.30 of this manual for additional troubleshooting steps.

※ This unit generates x-ray by an inverter. Therefore, it requires warm up time to be stable after power on and each exposure. When WARM UP indicator is off, warm up is finished.

5.0 Pre-adjustment

※ Each PC Board delivered from the factory has already been adjusted.

5-1. 24 VDC power supply adjustment (SVB24SA)

Check output (DCV) at Red (+) and Black (−) wires. Adjust VR on the SVB24SA to be $C24V \pm 0.3V$.

5-2. M3108AH adjustment (Refer to page 8)

kV adjustment : **Turning VR1 clockwise decreases kV.**

1. This adjustment requires special test equipment (HF Tester).
2. Check the DC voltage between the kV (+) and GND on the test equipment (HF Tester).
3. Set the kV selector to 100 kV and turn VR1 so that the DC Voltage is 5.0V.
4. Check the voltage at each kV setting.
5. Finally check the kV by using an external kV tester such as the VICTOREEN NERO. The reading will indicate a little lower than the actual output because of the tester dynamics for high frequency x-ray production, so don't adjust over 99kV indicated by testing device.

mA adjustment : **Turning VR5 clockwise decreases mA.**

1. This adjustment requires special test equipment (HF Tester).
2. Check the DC voltage between the mA (+) and GND on the test equipment (HF Tester)..
3. Confirm the mA indicator to be 20 mA and turn VR5 so that the DC Voltage is 2.0 V.

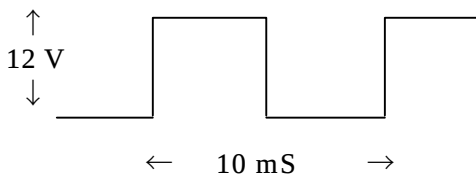
Exposure time adjustment : **Turning VR6 clockwise decreases exposure time.**

Time base is 100 Hz (10 msec.). When jumper of JP2 is pulled out, X-RAY LED is lit without relating to timer. Measure voltage between TIME test point and GND test point by Oscilloscope, and adjust by VR6.



IMPORTANT : Disconnect the connector JP2 on M3108AH PCB before removing the jumper of X-RAY. Otherwise, Inverter PC Board will work and X-RAY will be generated unrelated to timer setting and X-RAY unit might be damaged.

※ Push in and pull out connectors only with MAIN POWER OFF.



※TIME BASE WAVEFORM

NOTE : Please contact MinXray, Inc. (Service Department) for information about purchasing special test equipment (HF Tester).

5.0 Pre-adjustment

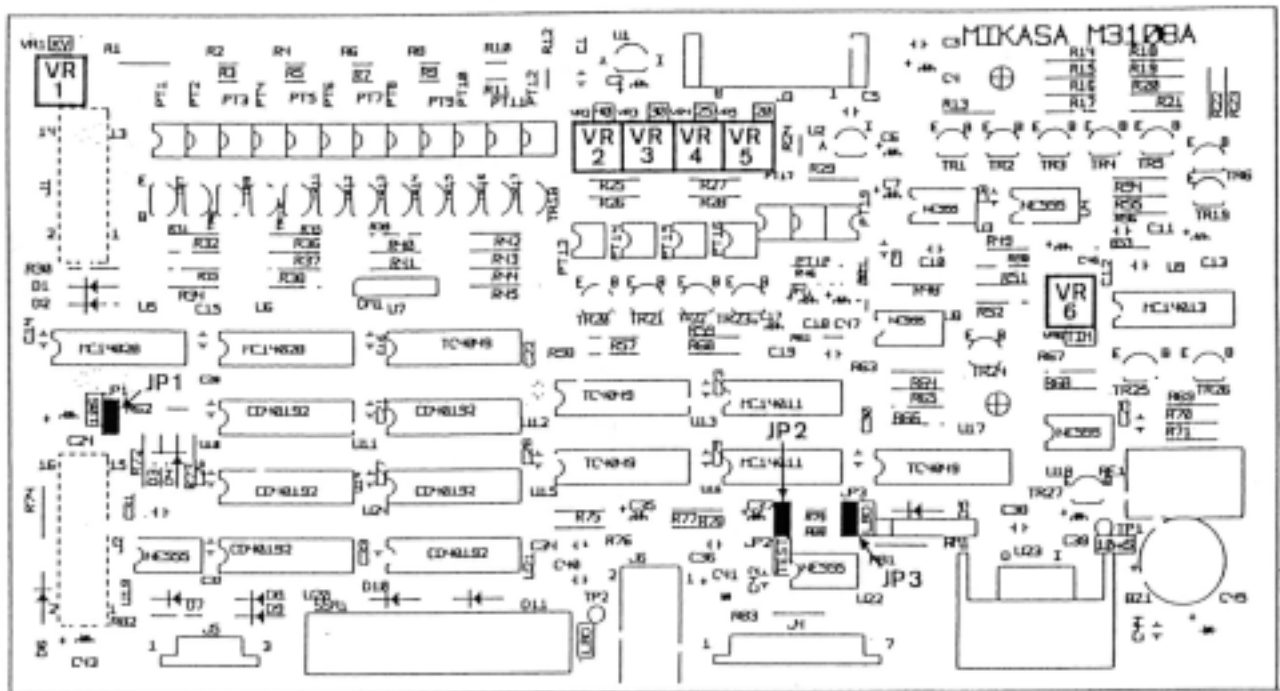
REFERENCE : There are three jumpers on M3108AH (10SEC ,TEST and LBD)

10SEC : When jumper is put in, WARM UP time is 1 sec. DO NOT USE. When jumper is pulled out, it is 10 sec.
This jumper is for adjustment at the factory before shipment.
So, please don't use the device with jumper.



TEST : **※NEVER PULL OUT THIS SHORT PIN. X-RAY WILL BE GENERATED PERMANENTLY AND DANGEROUSLY.**

LBD: Not used



5-3. M9111-1 PC Board adjustment (refer to page 9)

It can adjust the following:

- ※Over Voltage Protection circuit (VR1)
 - ※Over Current Protection circuit (VR2)
 - ※DC voltage adjust circuit (VR3)
- Calibrated DC voltmeter is necessary.

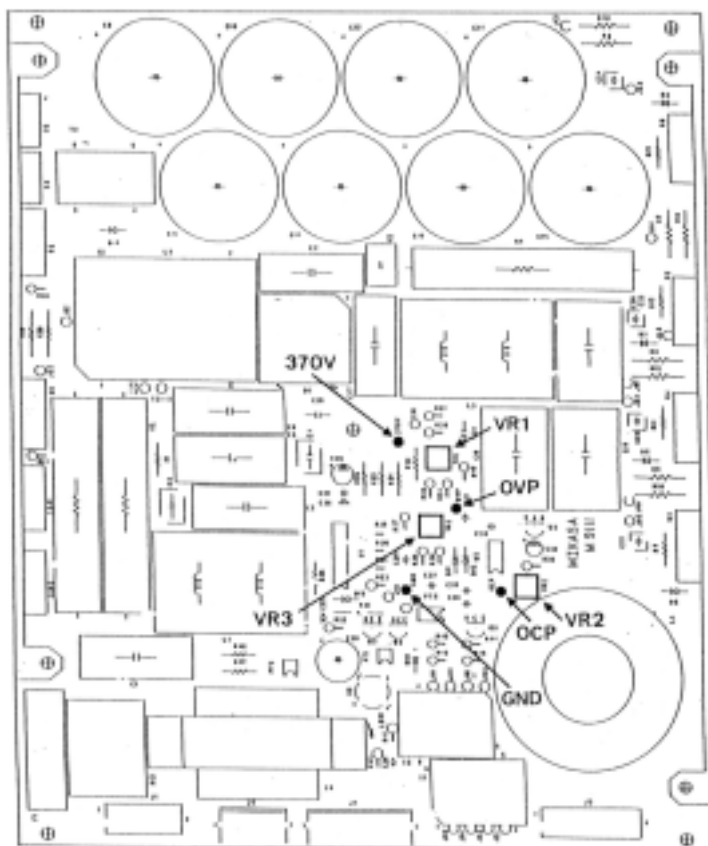
5-4. M9112 PC Board adjustment (refer to page 10)

It can adjust the following:

- ※Frequency of Inverter PC Board (VR1)
- ※Pre-heat time for Low mode (VR3)
- ※kV (VR4)
- ※mA (VR5)

5.0 Pre-adjustment

5-5. M9111-1 PC Board adjustment



**This adjustment has to be done after connecting all connectors completely.
Actual x-ray exposure is not necessary.**

※Each PC Board delivered from the factory has been already adjusted.

1. Adjustment of VR3 (DC370V)

Adjust voltage between 370 (+) and GND (–) to be 368.5 – 372 V by turning VR3.

Turning clockwise increases voltage.

2. Adjustment of VR2 (Over Current Protection circuit)

Adjust voltage between OCP(+) and GND (–) to be 1.09 – 1.11 V by turning VR2.

Turning clockwise increases voltage.

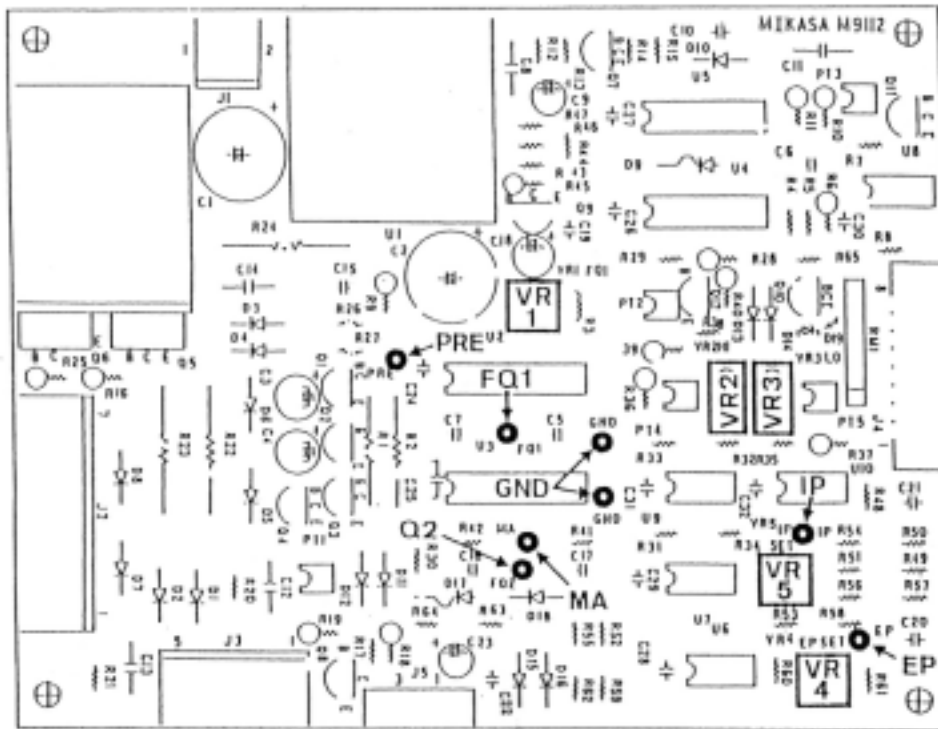
3. Adjustment of VR1 (Over Voltage Protection circuit)

Adjust voltage between OVP (+) and GND (–) to be 2.4 – 2.45 V by turning VR1.

Turning clockwise decreases voltage.

5.0 Pre-adjustment

5-6. M9112 PC Board adjustment



This adjustment has to be done after connecting all connectors completely. Actual x-ray exposure is not necessary.

※Each PC Board delivered from the factory has been already adjusted.

1. Adjustment of FQ1

Adjust frequency between FQ1 (+) and GND (–) to be 120 kHz by turning VR1.

Turning clockwise increases frequency.

2. Confirmation of FQ2

Confirm if frequency between FQ2 (+) and GND (–) is 90 kHz $\pm 5\%$. It cannot be adjusted.

3. Adjustment of Pre-heat voltage at 20 mA.

Adjust voltage between PRE (+) and GND (–) to be 0.43 V by turning VR3.

Turning clockwise increases voltage.

4. Set VR4 (EP SET) to the center position.

5. Set VR5 (IP SET) to the center position.

6.0 Re-adjustment of kV



This adjustment has to be done after connecting all connectors completely. Actual exposure is necessary.

NOTE : This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.

※This adjustment should be done whenever Insert Box or Inverter PC Board (M9111-1 PCB) is replaced.

Oscilloscope (with storage mode) : Connect CH1 probe to EP, CH2 probe to IP, and GND to GND terminal on M9112 PC Board. (refer page 10)

Setting of oscilloscope : CH1 ; 1 V/div, CH2 ; 0.5 V/div, 10 msec/div

Setting of x-ray output : 0.1 sec., 70 kV

Place of adjustment : VR4 on M9112 PC Board (EP SET)

Method of adjustment : Measure x-ray tube voltage by oscilloscope and adjust average of peak values of EP waveform to be 3.4 V by VR4.
After the adjustment is finished, set x-ray output to be 100kV and adjust again so that average of peak values of EP waveform to be 4.9 V.

.



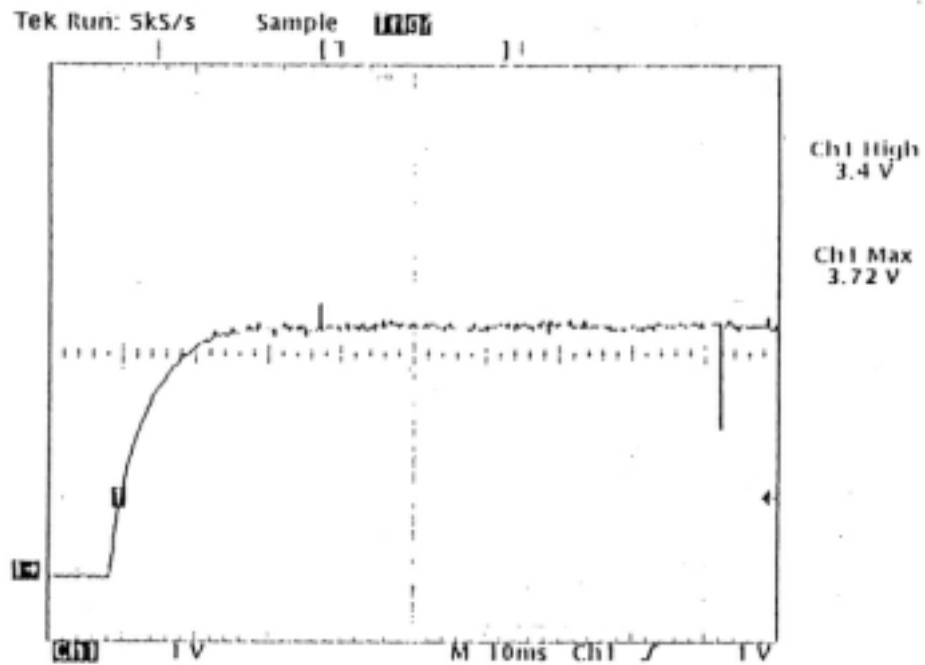
When x-ray tube voltage is measured by non - invasive direct x-ray measuring equipment such as NERO, approx. 3 kV of deviation is included. Therefore, adjust kV to be 97.5 ~ 99 kV at 100 kV station.

6.0 Re-adjustment of kV

6-1. Adjustment of 70 kV by VR4

Adjust the ch1 (Ep) by VR4 to be $3.4 \text{ V} \pm 0.5 \text{ V}$.

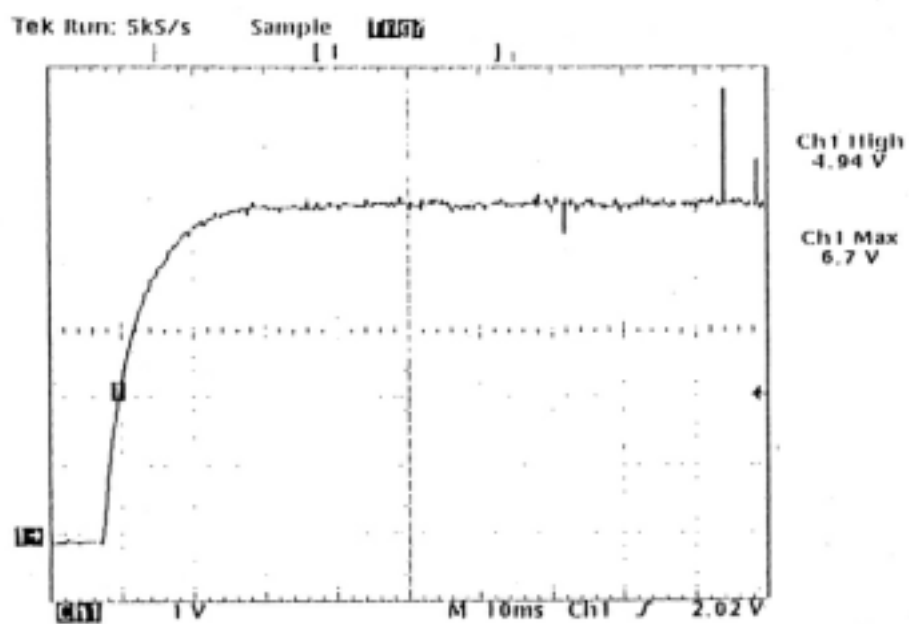
Turning clockwise increases kV.



6-2. Adjustment of 100 kV by VR4

Adjust the ch1 (Ep) by VR4 to be $4.9 \text{ V} \pm 0.5 \text{ V}$.

Turning clockwise increases kV.



7. 0 Re-adjustment of Pre-heat and mA



This adjustment has to be done after connecting all connectors completely.
Actual exposure is necessary.

NOTE : This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.

*This adjustment should be done whenever Insert Box or Inverter PC Board (M9112 PCB) is replaced.

Oscilloscope (with storage mode) : Connect CH1 probe to EP, CH2 probe to IP, and GND to GND terminal on M9112 PC Board. (refer page 10)

Setting of oscilloscope : CH1 ; 1 V/div, CH2 ; 1 V/div, 10 msec/div

Setting of x-ray output : 0.1 sec., 80 kV

Place of adjustment : VR3 (Pre-heat voltage) • VR5 (mA)

VR3 : adjustment of Pre-heat time at 25~20 mA.
(Pre-heat time is shorten by turning clockwise.)

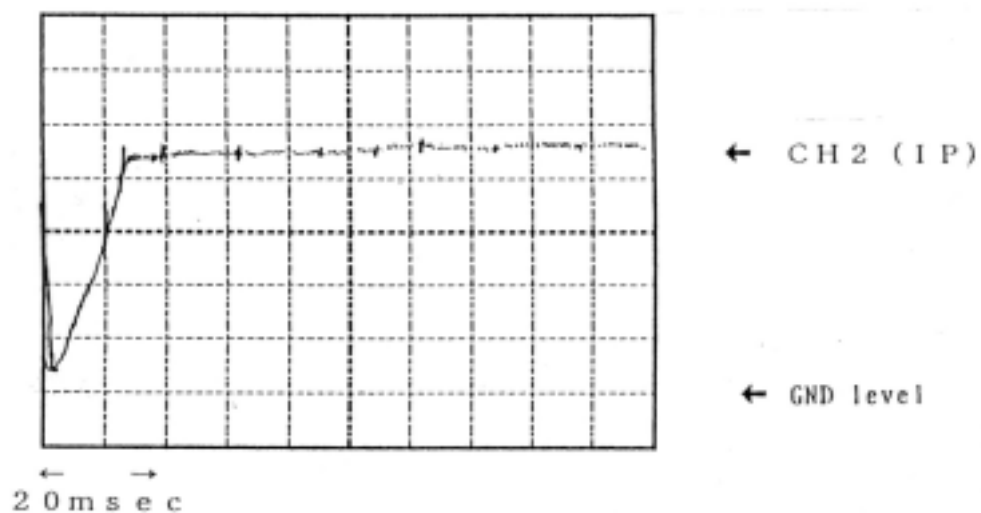
VR5 : set 20 mA and adjust to be 19 mA

※Pre-heat time should be adjusted to be 30 msec.±10 msec.

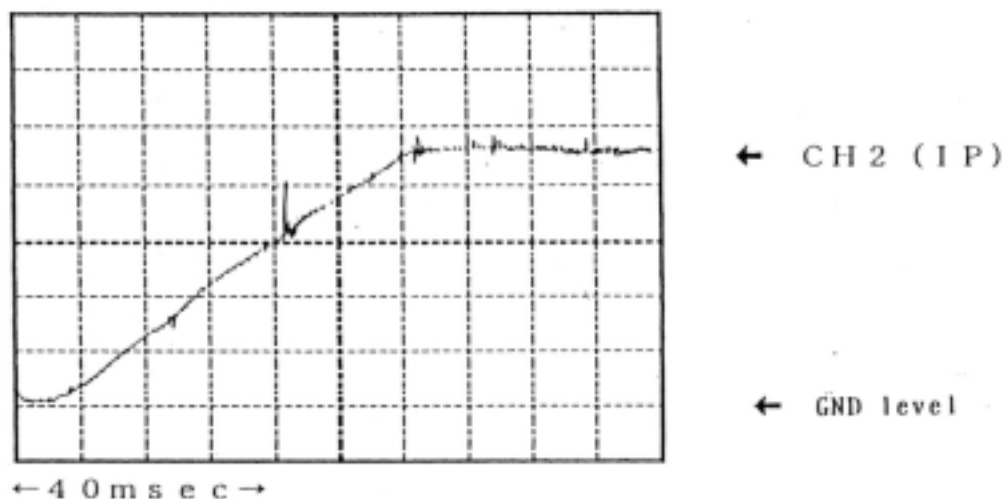
7.0 Re-adjustment of Pre-heat and mA

7-1. Adjustment of Pre-heat time

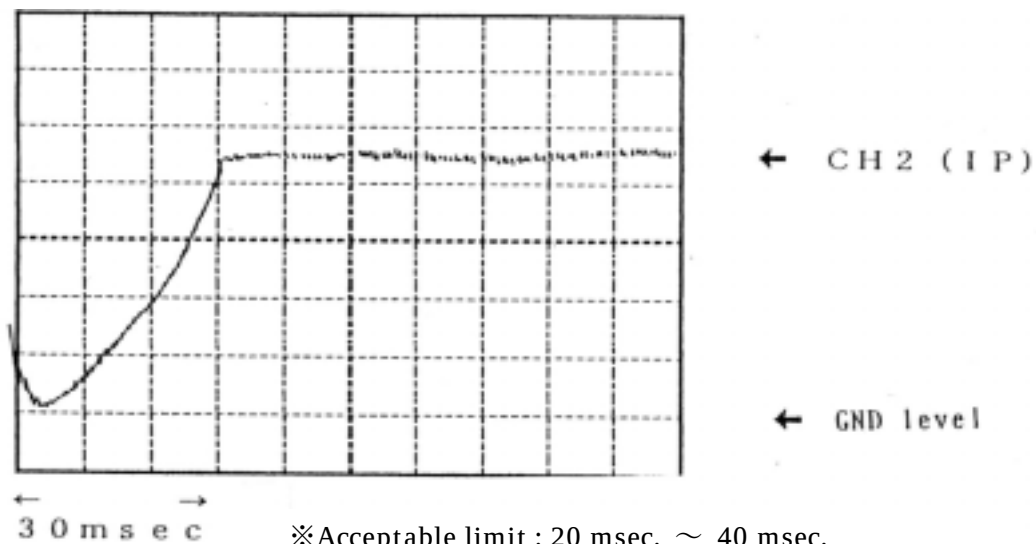
1. Pre-heat time is short. Make Pre-heat time longer by turning VR3 counterclockwise.



2. Pre-heat time is long. Make Pre-heat time shorter by turning VR3 clockwise.



3. Pre-heat time is appropriate.

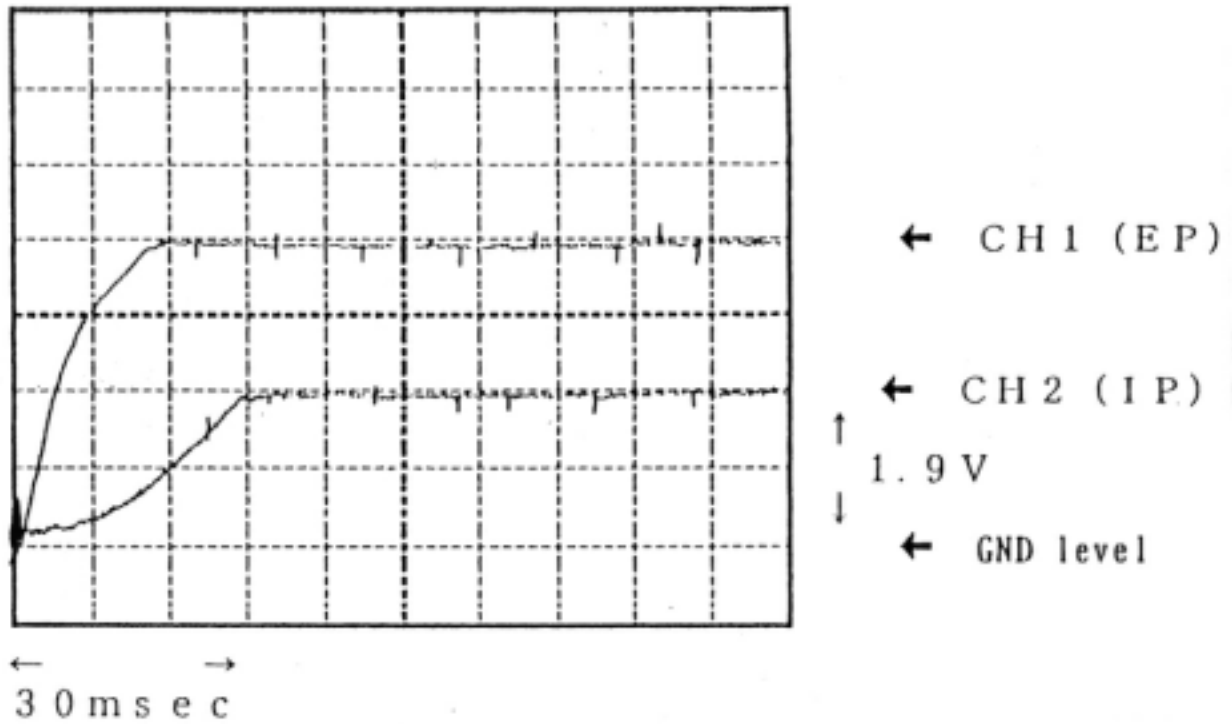


※Acceptable limit : 20 msec. ~ 40 msec.

7.0 Re-adjustment of Pre-heat and mA

7-2. Adjustment of mA by VR5

※Adjust average of peak values of IP waveform to be 1.9 V by VR5.



8.0 Re-adjustment of exposure time



This adjustment has to be done after connecting all connectors completely.
Actual exposure is necessary.

NOTE: This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.

Check the exposure time by using an external exposure time meter such as the VICTOREEN NERO.

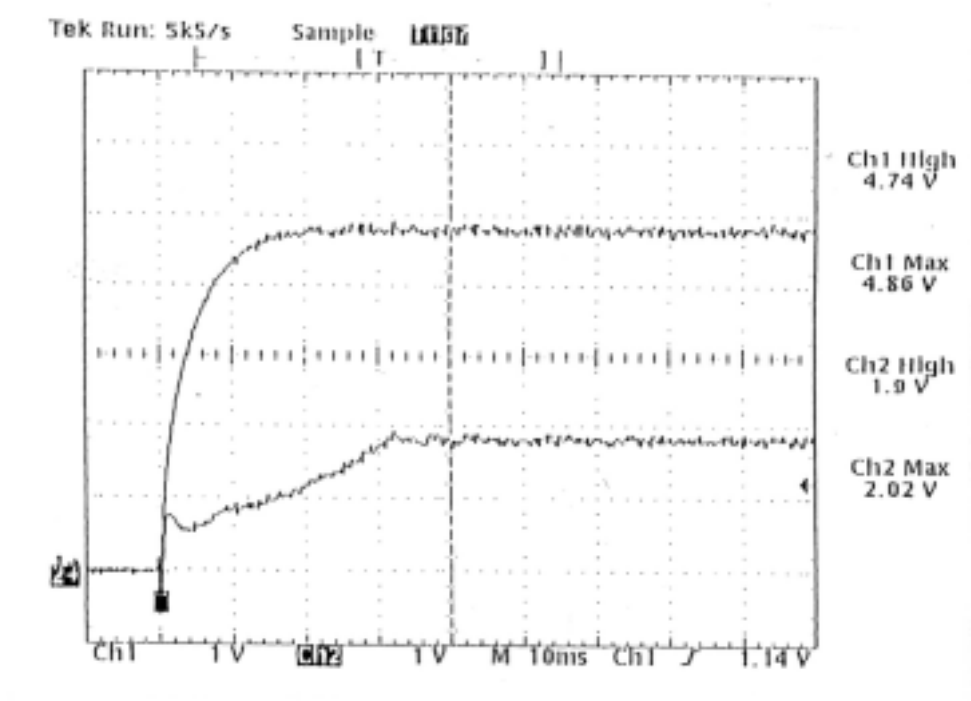
X-ray unit setting: 82 kV • 0.5 sec

Adjustment: Turning clockwise decreases exposure time. (VR6 on the M3108AH PC board)

9.0 Sample of output waveform

Normal waveform

100 kV · 20 mA



10.0 Pre-adjustment of mA with/without HF Tester

10-1 Pre-adjustment of mA with HF Tester

※The HF tester is a tool to inspect and adjust the *HF100H* control panel. It is specially manufactured and can be purchased only from MinXray, Inc.

The upper control panel is removed from the body after four screws on the side of the body are removed.

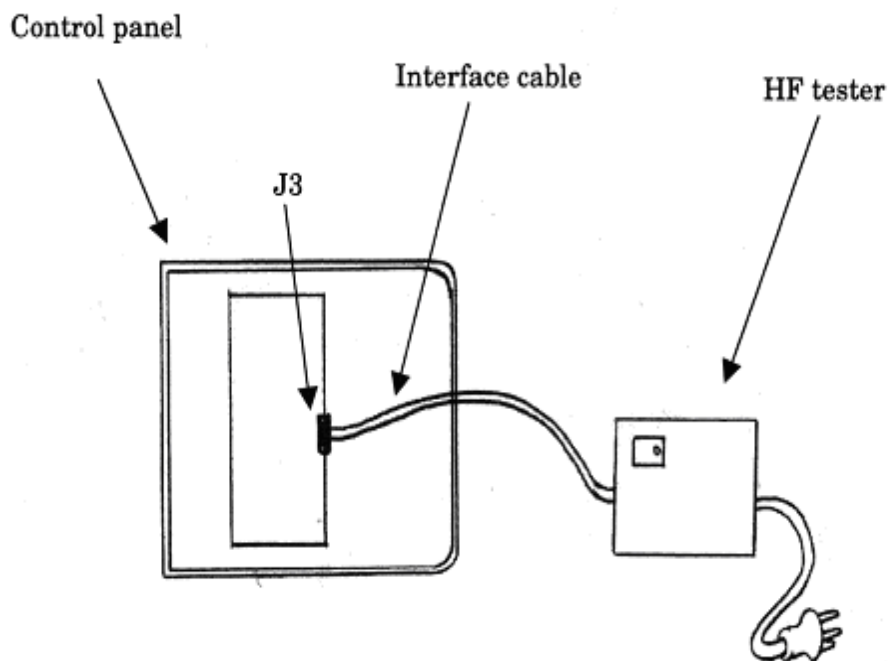
The control panel is connected with the body with three cables: the power supply cable, interface cable and earth wire. Remove these three cables.

Connect a HF tester to a 115 V AC power supply, and turn on its power switch.

kV can be measured with kV+ and GND terminal.

mA can be measured with mA+ and GND terminal.

Exposure time can be measured with TIM+ and the GND terminal.



10.0 Pre-adjustment mA with/without HF Tester

10-2 Pre-adjustment mA without HF Tester

※ Each PC Board delivered from the factory has already been adjusted.

1. M3108AH adjustment (Refer to page 8)

kV adjustment : **kV is decreased by turning VR1 clockwise.**

1. Set the kV selector to 100 kV.
2. Check the DC voltage between the connector J3-8 pin (+) and J3-2 pin (-) on the M3108AH PC board. (Do not remove any cable.)
3. Adjust the DC voltage to be 5 V by turning VR1.

mA adjustment : **mA is decreased by turning VR5 clockwise.**

1. Confirm the mA indicator to be 20 mA.
2. Check the DC voltage between the connector J3-3 pin (+) and J3-2 pin (-) on the M3108AH PC board. (Do not remove any cable.)
3. Adjust the DC voltage to be 2 V by turning VR5.

11.0 Measure mA by mA jack output

mA Jack (Single round phone jack, 3.5 mm diameter) connection diagram



1. Close the collimator shutters fully.
2. Connect voltage measurement equipment (ex. Oscilloscope) with mA jack (Single round phone jack, 3.5mm/dm) to socket on the back of the *HF100H*.
3. Make exposure.
4. Measure voltage of mA Jack 's output. (Single round phone jack,3.5 mm/dm)
5. Calculate the mA as follows : $20 \text{ mA} = 2.00 \text{ V}$

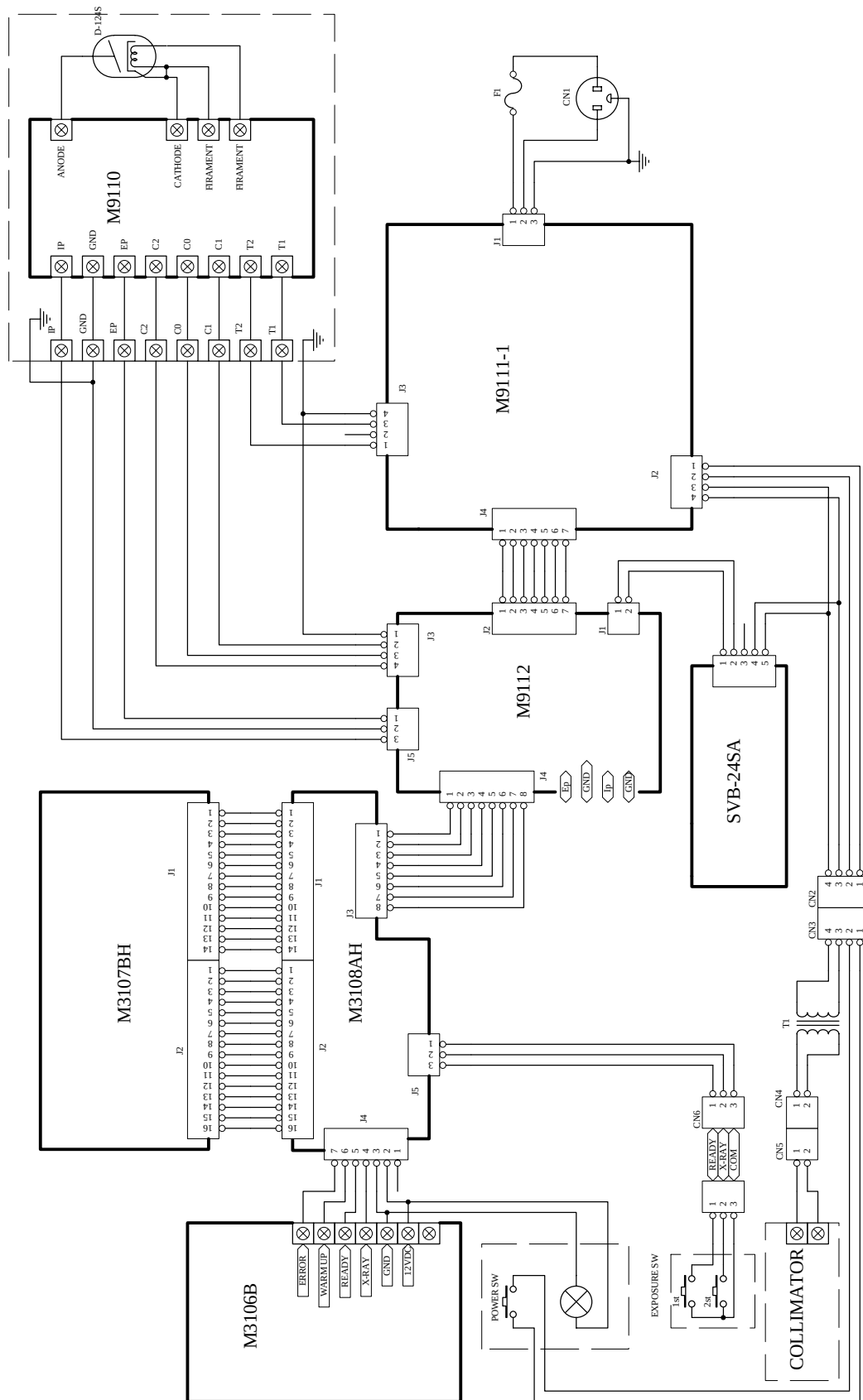


This measurement requires that an exposure be made. During the measurement, close the collimator shutters fully to block the primary X-ray.

Note: Only voltage value can be measured from mA jack output.

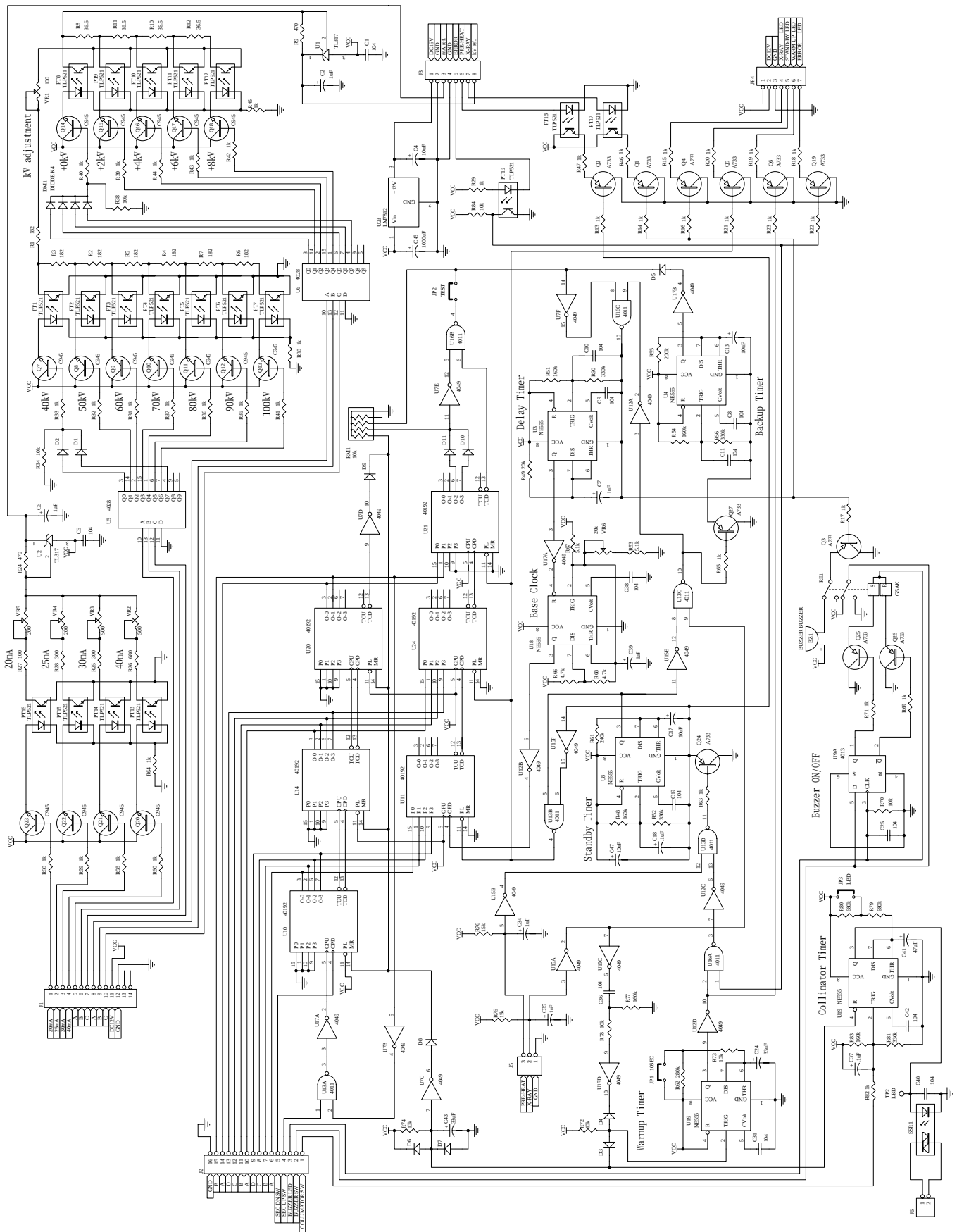
mA jack 's output just can be measured only during x-ray exposure.

12.0 Wiring Diagram



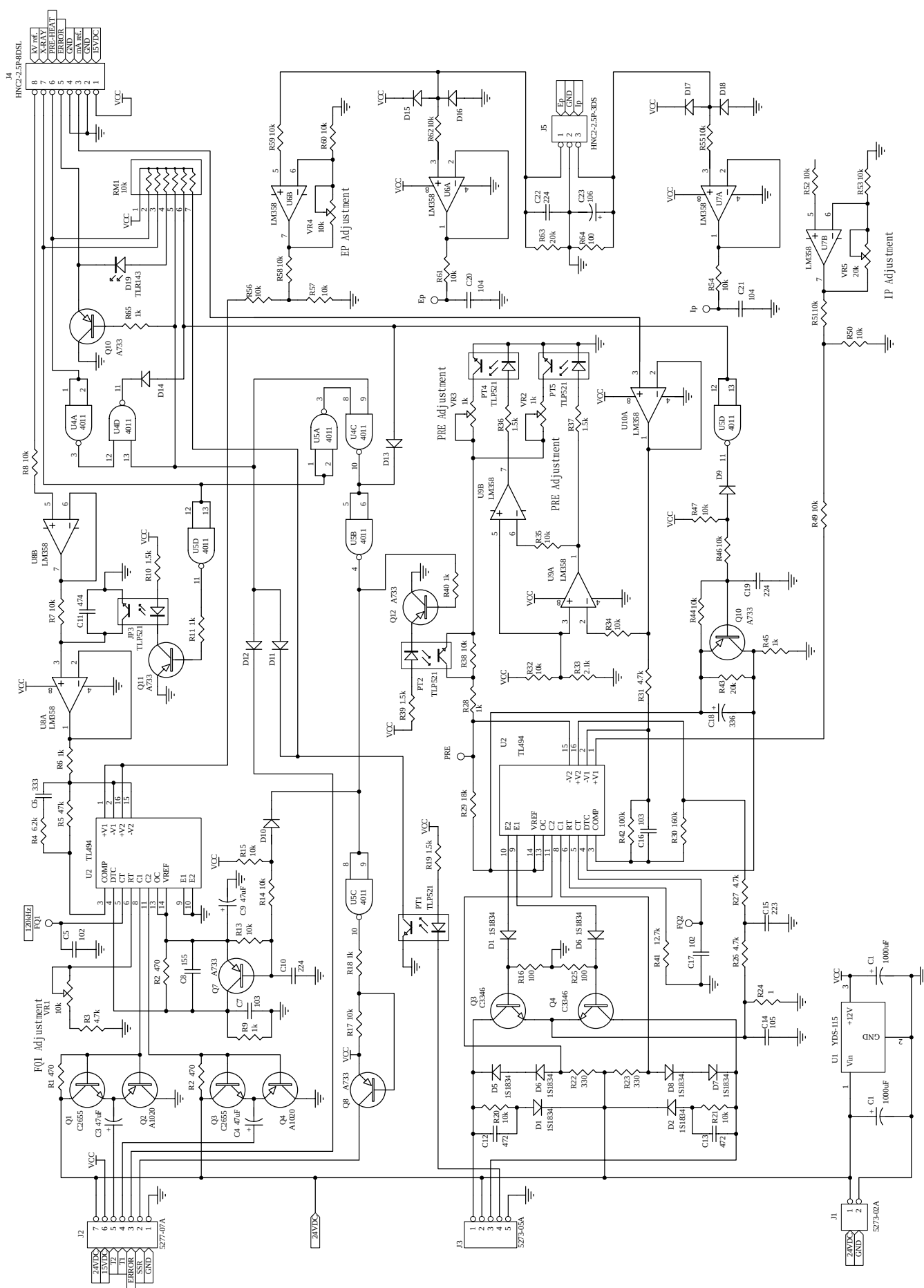
13.0-1 Schematic Diagram

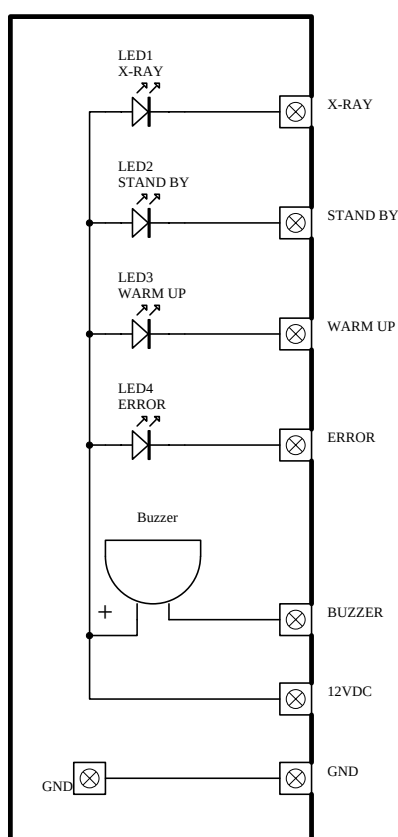
PCB M3108AH

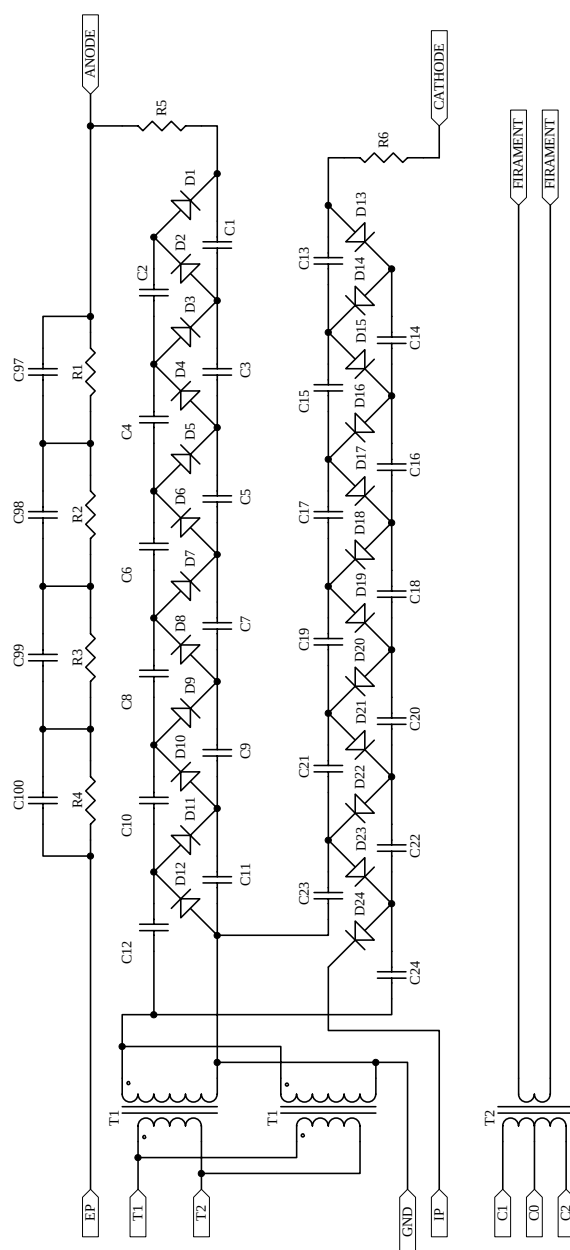


13.0-4 Schematic Diagram

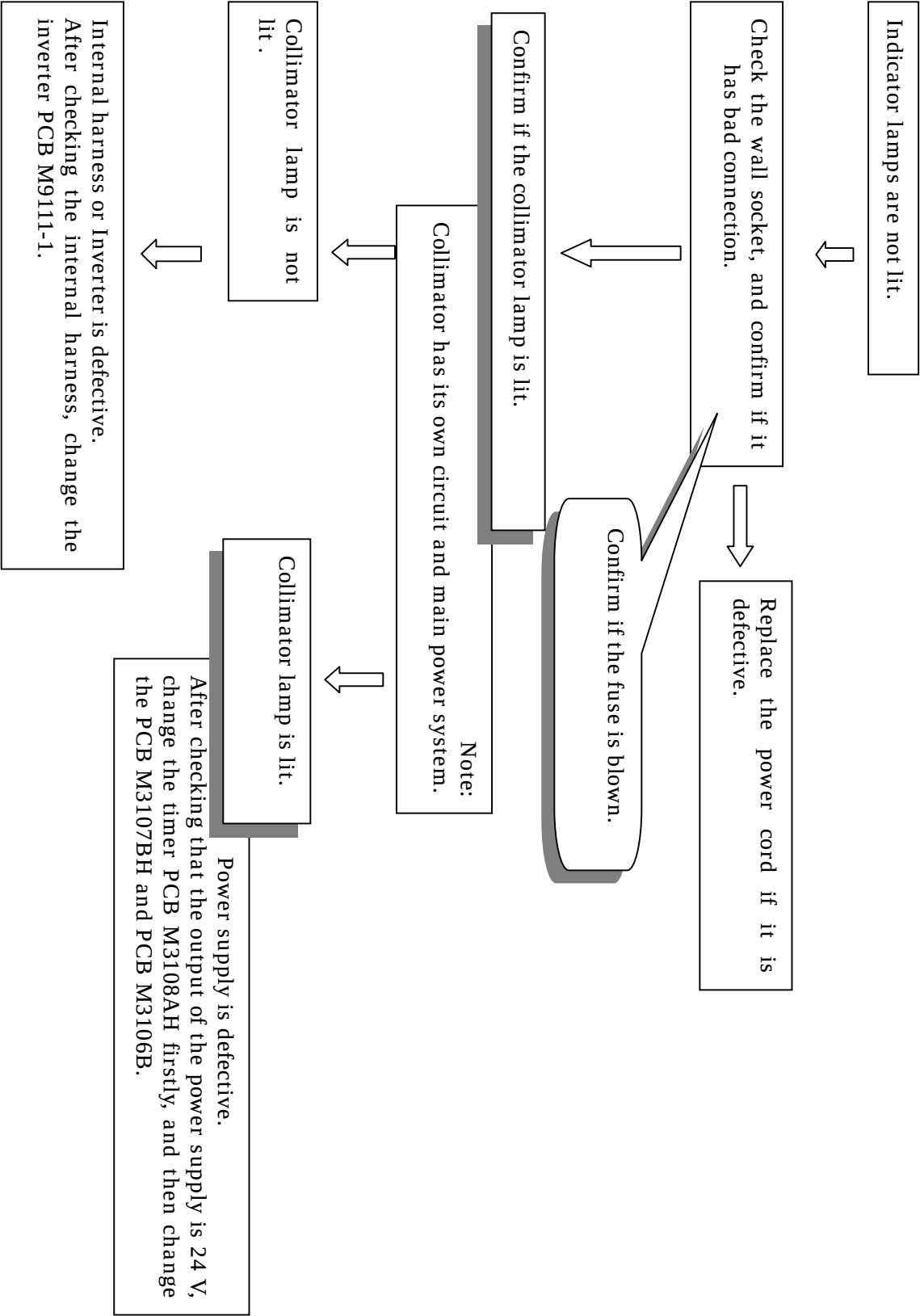
PCB M9112



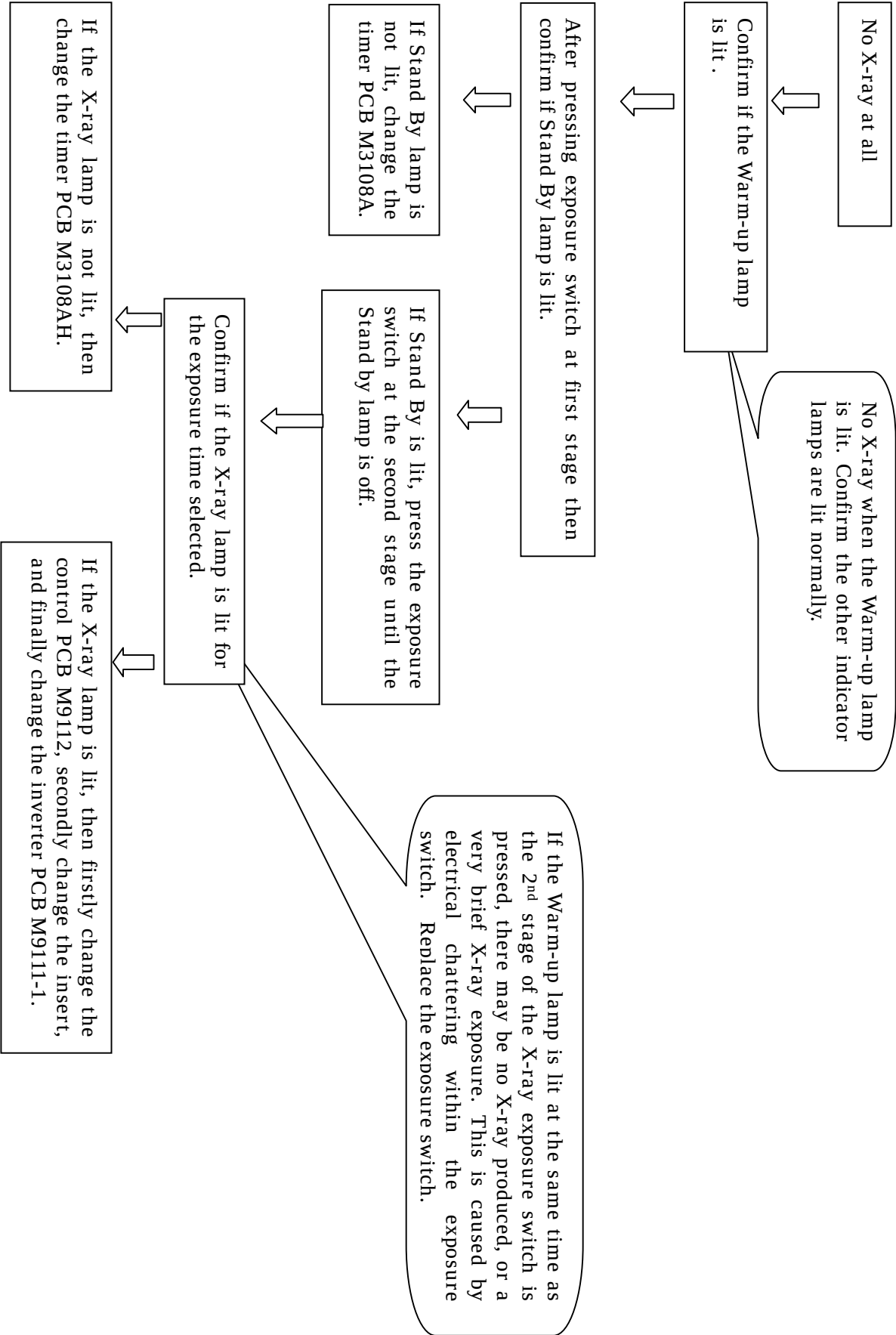




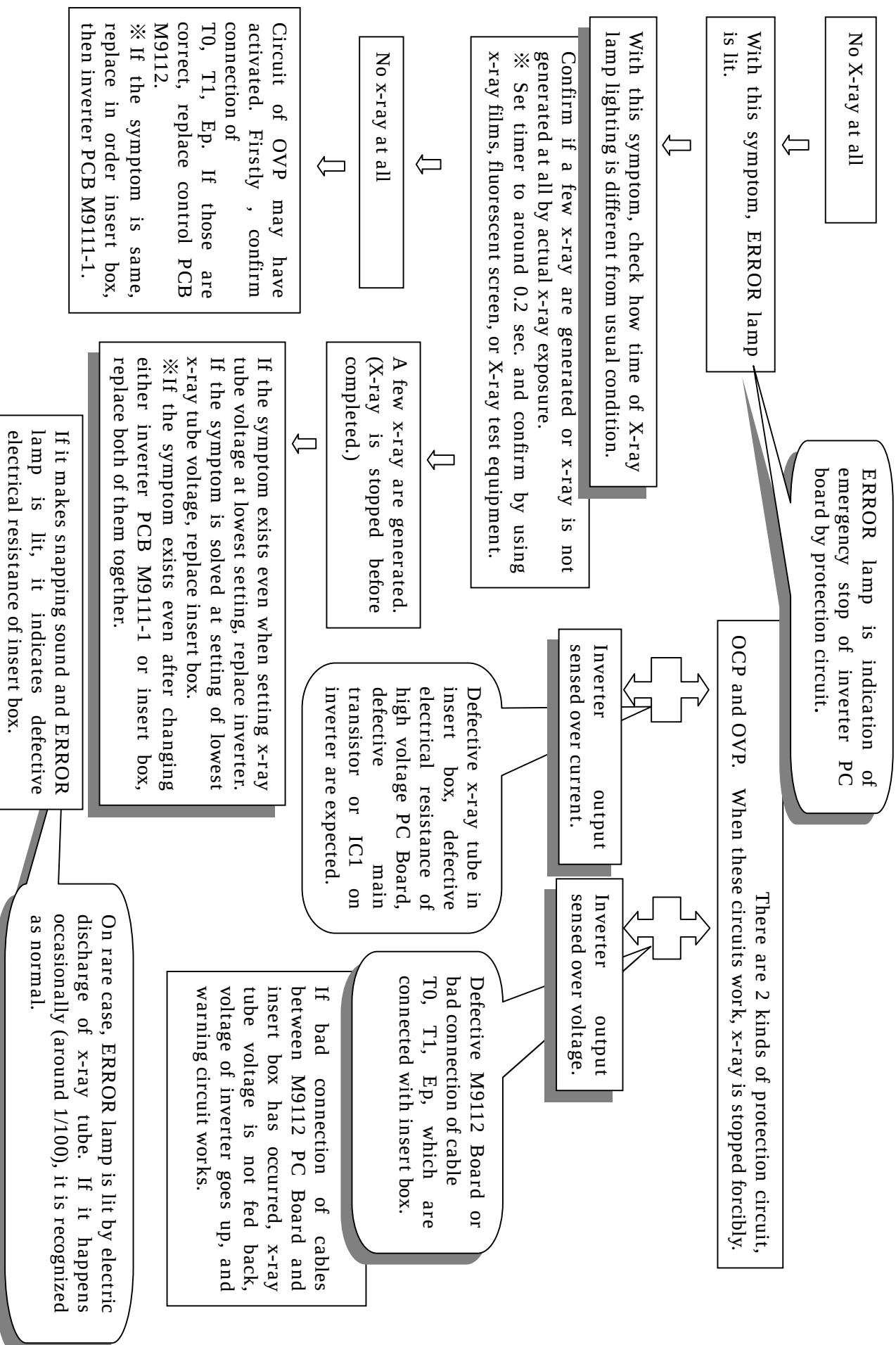
1. INDICATOR LAMPS ARE NOT LIT WHEN POWER SWITCH IS AT “ON” POSITION



2. NO X-RAY AND ERROR LAMP IS NOT LIT



3. ERROR LAMP IS LIT AND NO X-RAY



4. INTERMITTENT GENERATION OF X-RAY

X-Ray is not generated intermittently.



Confirm ERROR lamp is not lit.

If ERROR lamp is lit on this symptom, refer (1. ERROR LAMP IS LIT AND NO X-RAY)



Confirm Warm-up lamp is not lit until release of exposure switch.

If Warm-up lamp is lit as soon as press the second stage of exposure switch, it caused by failure of something around exposure switch.
* Test the unit with new exposure switch.



When this symptom occurs, check if time of actual exposure is same with usual exposure.

At normal condition, Warm-up lamp turns on just after release second stage of exposure switch.
If exposure switch chatters, Warm-up lamp is lit as soon as press second stage of exposure switch.

Confirm if a few x-rays are generated or x-ray is not generated at all by actual x-ray exposure.
* Set timer to around 0.2 sec. and confirm by using x-ray film, fluorescent screen , or x-ray test equipment.



No x-ray at all.



A few x-rays are generated. (X-ray is stopped before completed.)



If the symptom is not solved by replacement of insert box, replace inverter, too.

On rare case, ERROR lamp is lit by electric discharge of x-ray tube. If it happens occasionally (around 1/100), it is recognized as normal.

M9112 PC Board is defective. Replace it.

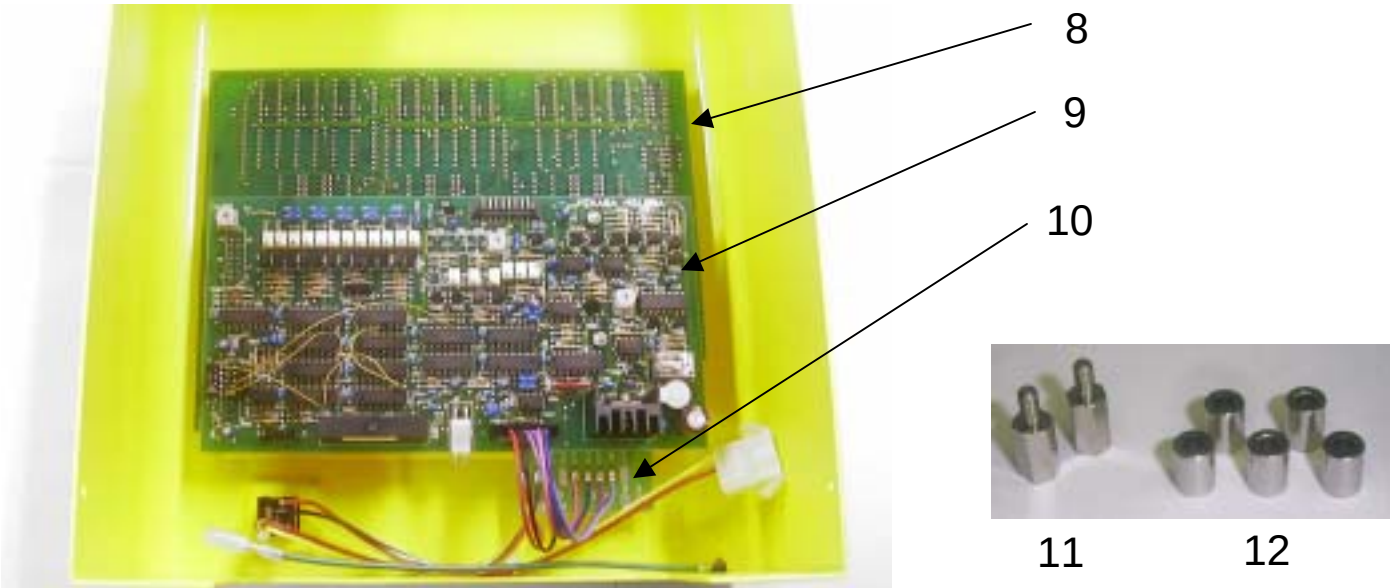
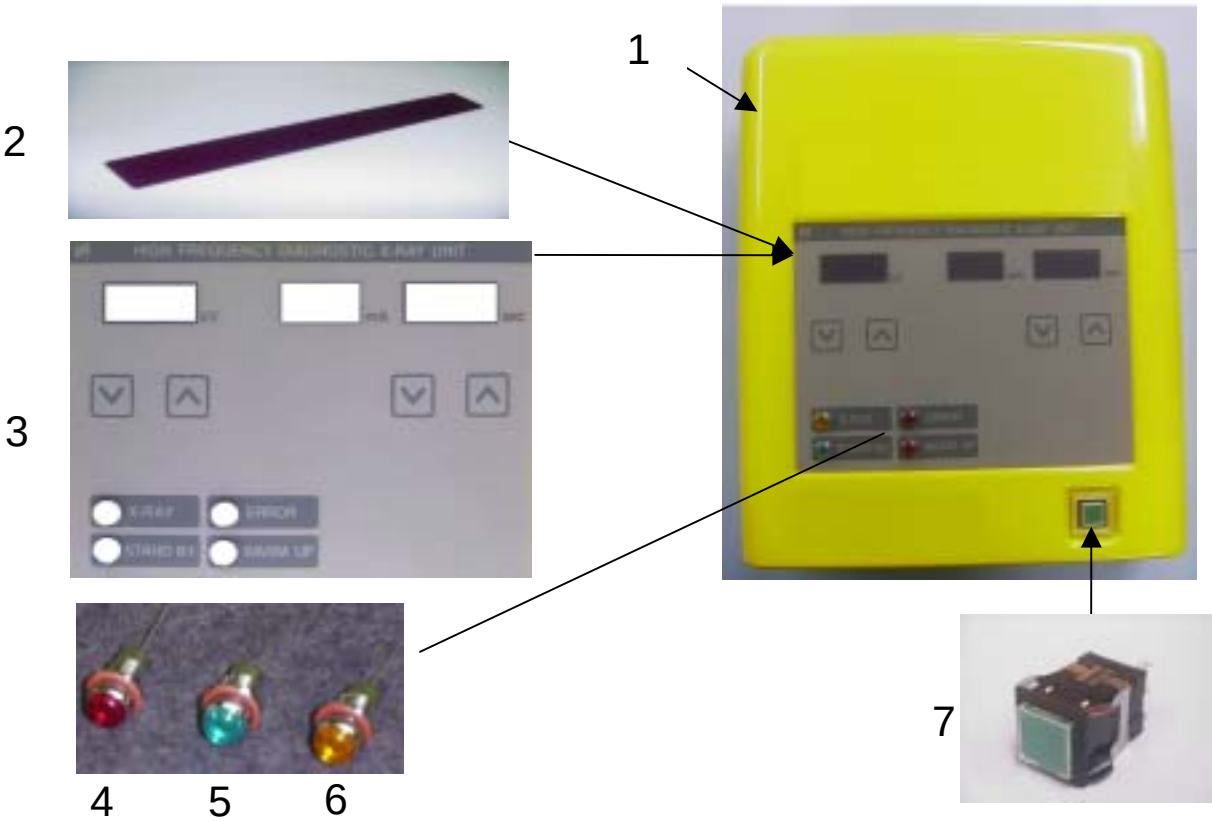
* If the symptom is not solved, replace insert box, too. If the symptom is still not solved, also replace inverter.

On rare case, IC on M9112 PC Board is damaged by abnormal electrical discharge of x-ray tube.

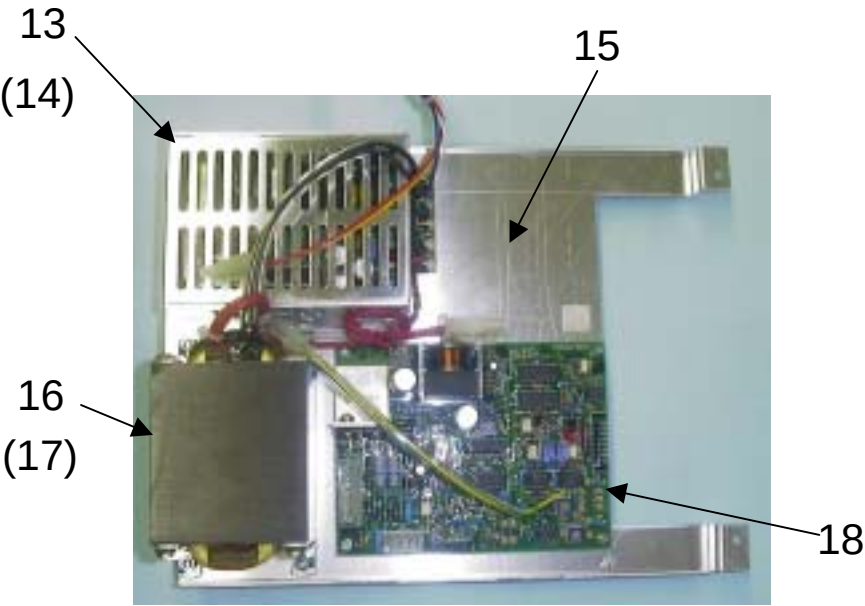
15.0 Parts List

No.	Parts No.	Designation	PHOTO	Qty
1	11169	Collimator (Collimax D—180HS-G) (S/No. 25150 ~ S/No.25621)	45	1
2	11213	Collimator (Advantech R72/32) (Except S/No. 25150 ~ S/No.25621)	40	1
3	10749	LOWER CASE (Except S/No.25150 ~ S/No.25621)	44	1
4	11217	LOWER CASE (S/No. 25150 ~ S/No.25621)	23	1
5	10586	PLASTIC FOOT	30	4
6	10688	FUSE HOLDER	22	1
7	10742	POWER RECEPTACLE	21	1
8	10755	EXPOSURE SWITCH CORD RECEPTACLE	20	1
9	10690	MOUNTING PLATE (WITHOUT DEGREES)	27	2
10	10081	NYLON WASHER	29	4
11	10082	METAL SPACER	24	2
12	10083	SPLIT LOCK WASHER	25	2
13	10084	HOLDING SCREW	26	2
14	10584	LEAD CUP WITH 1.0mm AL FILTER	38	1
15	10818	HOLDING PARTS	28	2
16	10756	FRONT PANEL (YELLOW)	36	1
17	10736	SPACER FOR COLLIMATOR	35	1
18	11221	Collimator mounting plate	37	2
19	10691	PCB M9111(Inveter, 115V)	31	1
20	10829	PCB M9111(Inveter, 230V)	49	1
21	10692	SIDE FRAME (S/No. 25150 ~ S/No.25621)	48	2
22	11218	SIDE FRAME (Except S/No. 25150 ~ S/No.25621)	33	2
23	11066	INSERT for S/No. 25150 ~ S/No.25621(Collimax collimator)	46	1
24	10695	INSERT for except S/No. 25150 ~ S/No.25621(Advantech collimator)	32	1
25	11142	BRASS RING (S/No. 25150 ~ S/No.25621)	50	1
26	10126	BRASS RING (Except S/No. 25150 ~ S/No.25621)	34	1
27	10696	CHASSIS	15	1
28	10697	SPACER (M3 X 5)	19	4
29	10718	PCB M9112	18	1
30	10757	COLLIMATOR TRANSFORMER (474-1002, for 120V)	16	1
31	10758	COLLIMATOR TRANSFORMER (474-1003. for 230V)	17	1
32	10750	POWER SUPPLY (SVB-24-SA, for 120V)	13	1
33	10699	POWER SUPPLY (SVB-24-SB, for 230V)	14	1
34	10752	PCB M3108AH (HF100H)	9	1
35	10585	SPACER (M3 X 10)	11	2
36	10895	PCB M3107BH (HF100H)	8	1
37	10841	Collar(8mm)	12	5
38	10703	PCB M3106 (WITH CORD) (7 segment)	10	1
39	10748	UPPER CASE (YELLOW)	1	1
40	10076	ORNAMENT WASHER FOR ORNAMENT SCREW M3	42	4
41	10075	ORNAMENT SCREW (EP-M3 X 8)	43	4
42	10714	LED INDICTING LAMP (ORANGE)	6	1
43	10713	LED INDICTING LAMP (GREEN)	5	1
44	10715	LED INDICTING LAMP (RED)	4	1
45	10760	SHEET KEY PLATE	3	1
46	10662	POWER SWITCH (MORON-FHA WITH SHIELD)	7	1
47	10709	PLASTIC SHIELD PLATE	2	1
48	11162	EXPOSURE SWITCH(HS-M1)	41	1
49	11163	EXPOSURE SWITCH CORD for HS-M1	47	1
50	11222	SCREW (bolt)	35	4

HF100H parts list (Photos) 1/5



HF100H parts list (Photos) 2/5



19



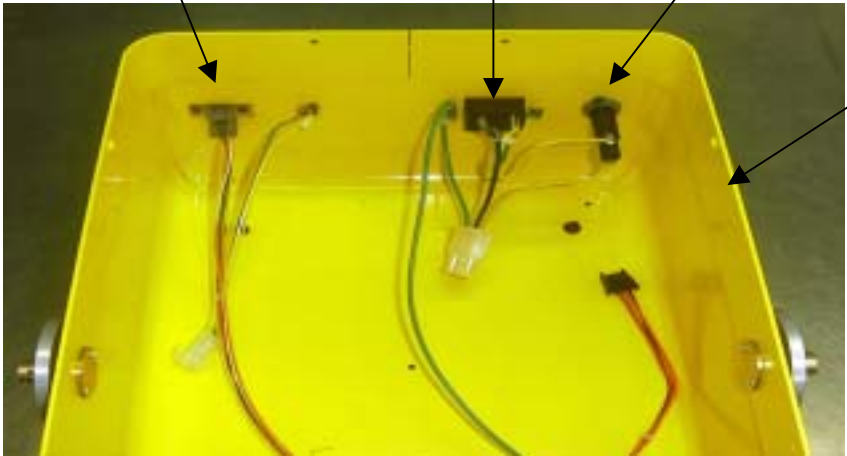
20



21



22

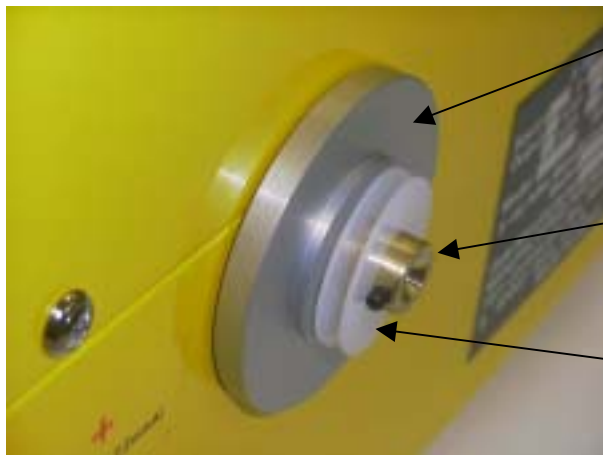


23
(44)

HF100H parts list (Photos) 3/5



24 25 26



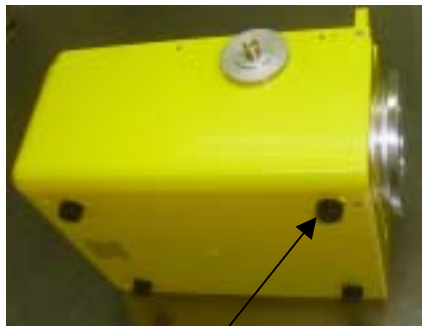
27



28



29



30

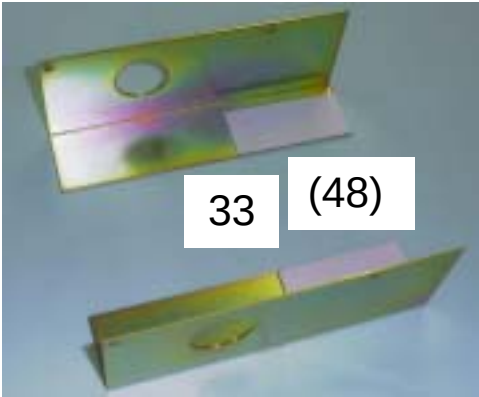


31
(49)

HF100H parts list (Photos) 4/5



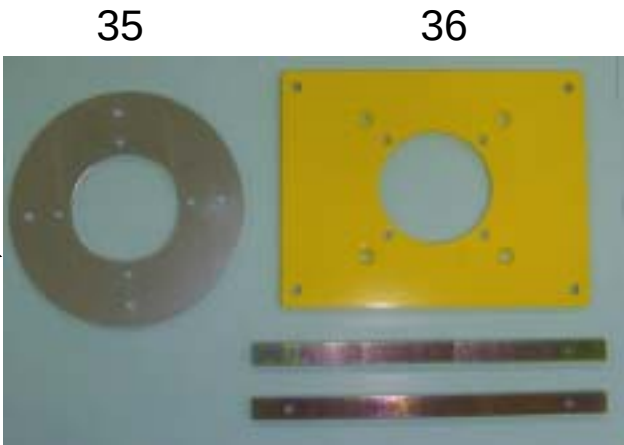
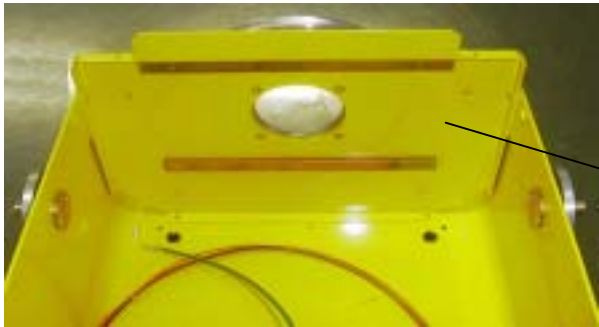
32 (46)



33 (48)



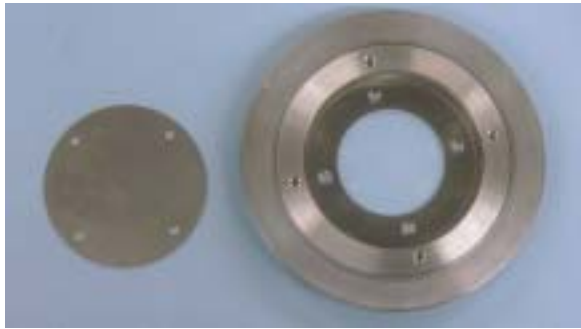
34 (50)



35

36

37



38

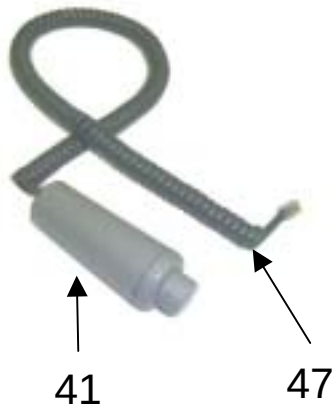


39

HF100H parts list (Photos) 5/5



40
(45)



41

47



42

43

**Advantech
Imaging
Systems**

10861 SE Stern Lane, Hobe Sound
Florida 33455 USA
800/500-9729
772/545-3500

MODEL R72/32

MANUALLY OPERATED
X-RAY COLLIMATOR



MODEL R72

DOCUMENT EFFECTIVITY

REVISION N.	DATE	COMMENTS
A	10.04.2002	MRD/007/02 - Modification of Spare parts - modified pages: Charter L) - SPARE PARTS and P) - FIGURES, DIAGRAMS, TABLES.

CONTENTS

A) WARNINGS	A—1
B) DESCRIPTION	B—1
Table on the front panel:	B—3
C) SPECIFICATIONS:	C—1
Included with the collimator :	C—1
Optional:	C—1
Symbols	C—2
COMPATIBILITY WITH X-RAY TUBE HOUSING ASSEMBLIES:	C—3
D) MOUNTING THE COLLIMATOR TO THE X-RAY TUBE:	D—1
E) ELECTRICAL POWER CONNECTION:	E—2
Power supply connection:	E—2
F) COLLIMATOR CALIBRATION:	F—1
1. Collimator to Focal Spot Alignment (Primary shutter Cut-off)	F—1
2. Centring the x-ray field with the light field	F—1
Light field to x-ray Field Alignment	F—2
Field Size Indication Adjustment	F—3
1) Shutter Dial Pre-Adjustment:	F—3
2) Shutter Dial Calibration:	F—3
Crosshairs, Alignment	F—5
Friction Brake Adjustment	F—5
G) Compliance verification	G-1
H) OPERATION INSTRUCTIONS	H—1
Light/x-ray field, adjustment:	H—1
I) ROUTINE MAINTENANCE	I—1
J) TROUBLESHOOTING	J—1
K) SUBSTITUTIONS, DISASSEMBLY, TRANSPORT	K—1
Substitutions:	K—1
Substitution of the lamp:	K—1
Substitution of the electronic timer (versions featuring the timer):	K—1
Disassembly	K—1
Transport	K—2
L) SPARE PARTS:	L—1
Label:	L—1
M) REPAIRS	M—1
N) END OF LIFE DISPOSAL	N—1
O) WARRANTY:	O—1
P) FIGURES, DIAGRAMS, TABLES	P—1
Figure 1	P—1
Figure 2	P—2
Figure 3	P—3
Figure 3	P—3
Figure 4	P—4
Figure 5 - parts breakdown	P—5
Diagram 1 -Electronic Timer Board FM338	P—6
Diagram 1 -Electronic Timer Board FM338	P—6
Diagram 2 -Electronic Timer Board, Electric	P—7
Diagram 3 Board layout 24V	P—8

A) WARNINGS

TO THE USER OF THIS MANUAL

THE COLLIMATOR DESCRIBED HEREIN IS TO BE INSTALLED ON A GENERAL PURPOSE UNIT CONFORMING TO CEE 93/42, IEC NORMS IEC 601-1, IEC 601-1-2, IEC 601-1-3 AND 21 CFR SUB CHAPTER J OF THE CODE OF FEDERAL REGULATIONS.

CONFORMITY IS ENSURED ONLY IF THE COLLIMATOR IS INSTALLED AND USED AS INDICATED IN THIS MANUAL. THE USER OF THIS MANUAL IS REQUIRED TO READ AND CAREFULLY REVIEW THE INSTRUCTIONS AND CAUTIONS CONTAINED HEREIN EVEN IF THE PERSON IS PERFECTLY CONVERSANT WITH THE INSTALLATION OF X-RAY COLLIMATOR.

COLLIMATOR INSTALLATION AND SERVICE IS TO BE PERFORMED BY PERSONNEL AUTHORISED BY THE MANUFACTURER OF THE X-RAY SYSTEM OR BY ADVANTECH.

ANY PERSON ASSEMBLING, REPAIRING OR REPLACING THE COLLIMATOR INTO AN X-RAY SYSTEM MUST VERIFY COMPLIANCE WITH SAFETY STANDARDS COVERING ELECTROMEDICAL EQUIPMENT AND PERFORMING A SERIES OF TESTS INDICATING COMPLIANCE WITH 21 CFR SUB CHAPTER J OF THE PERFORMANCE STANDARDS. RECORDING THE DATA OBTAINED BEFORE RELEASING THE COLLIMATOR FOR USE IS REQUIRED, SUCH DATA WILL DEMONSTRATE AT LATER TIME THAT ALL TESTS WERE PERFORMED AND THE EQUIPMENT WAS LEFT IN FULL COMPLIANCE WITH THE STANDARDS.

PROPER INSTALLATION, OPERATION AND MAINTENANCE OF THE COLLIMATOR SHOULD EXCLUDE OPERATION PROBLEMS OF THE COLLIMATOR AND OF THE SURROUND EQUIPMENT SINCE ADVANTECH HAS SUCCESSFULLY PASSED EMC TESTING.

THE USEFUL X-RAYS AND SCATTERED RADIATION ARE DANGEROUS TO BOTH OPERATOR AND OTHERS IN THE VICINITY UNLESS ESTABLISHED SAFE EXPOSURE PROCEDURES ARE STRICTLY OBSERVED.

THOSE AUTHORISED TO OPERATE OR SERVICE THE EQUIPMENT MUST BE THOROUGHLY FAMILIAR WITH THE PROCEDURES REGARDING RADIATION PROTECTION.

FAILURE TO FOLLOW THE MANUFACTURER'S INSTRUCTIONS, OR MODIFICATION OF ANY COMPONENT BY USER OR ASSEMBLER WHICH WILL AFFECT RADIATION SAFETY, CAUSES THE USER OR ASSEMBLER TO ASSUME FULL RESPONSIBILITY FOR THAT PRODUCT.

THE INSTRUCTION MANUAL SUPPLIES INDICATIONS ON STANDARD OPTIONAL MATERIAL. SPECIFIC DATA REGARDING THE VERSION PURCHASED IS PROVIDED BY THE LABEL OR BY ANNEXED DOCUMENTATION

ADDRESS ENQUIRIES TO:

ADVANTECH IMAGING SYSTEMS, LLC

10861 SE STERN LANE

HOBE SOUND, FL 33455 USA

FAX. 772-545-3500 - EMAIL: ADVANTECH@BELLSOUTH.NET

B) DESCRIPTION

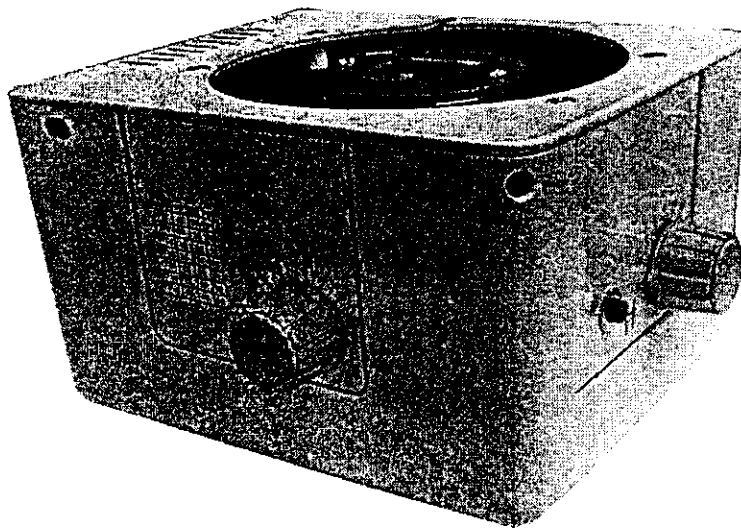
External cover in ABS plastic

Single-layer, square field radiological collimator

Its light weight and compact size allow easy positioning and make it ideal for portable units.

The X-ray field size is limited by two pairs of lead shutters controlled by two knobs located on the sides of the collimator and by a lead disc near the x-ray focus to reduce scattered radiation.

An indexed scale provides information on the field set with the knobs.

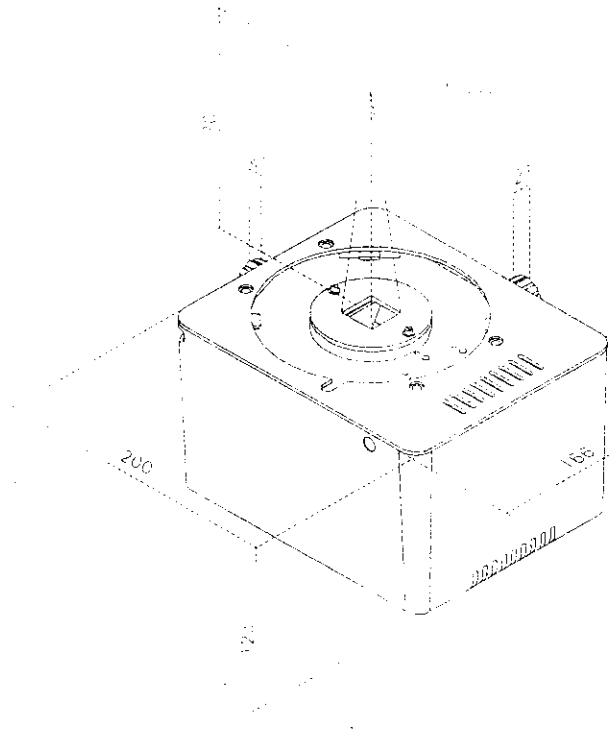


Specifications:

- Adjustment of mirror angulation may be performed by removing the outside cover.
- High luminosity of the light field projected by a quartz iodide lamp.
- Electronic timer that limits lamp-on time to 30 seconds - adjustable. This extends lamp life and prevents overheating.
- Radiation protection up to 125 kVp - 4 mA
- Inherent filtration 2mm aluminium equivalent. (1mm on request)
- Continuous film coverage from 0x0 cm $\pm$ 1% to 43x43 cm at an FFD of 90cm.

MODEL R72

Model R72 Series is a square field X-ray collimator designed for installation on **fixed anode tubes**. By means of two knobs placed a 90° one from the other, it allows the stepless adjustment of the X-ray field dimension to the size of the image receptor or to that of the anatomical area of interest.



The Collimator body contains 2 pairs of lead faced shutters controlled by means of two knobs. The shutters are positioned near the exit window.

The direct visualisation of the x-ray field is given by a light beam which corresponds to the x-ray beam, within a tolerance of one percent of the selected distance. The light-field center is provided by the intersection of two perpendicular silk-screened lines into the Lexan window and projected on the light field by the light beam.

To activate the light field, press light-related pushbutton  on the collimator. The light will switch on for 30 seconds (adjustable) and then automatically switch off.

Average illumination at 1m is minimum 160 Lux with a 100W,24V (100w, 12V optional) quartz iodide lamp; edge contrast ratio is >3:1

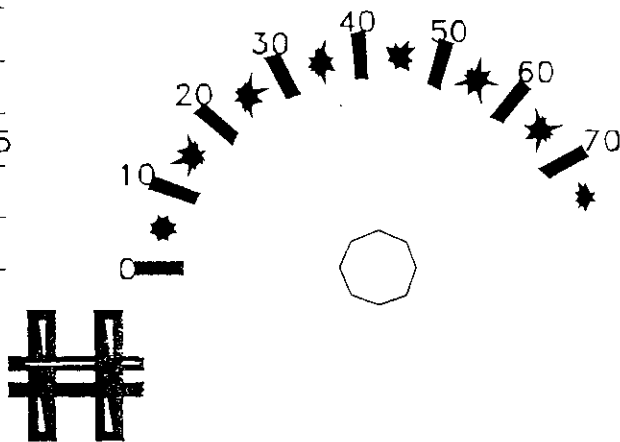
The field size at 90cm, 100cm and 180 cm Focus-Film Distances (FFD) (SID) is read on the collimator panel.

Table on the front panel:

The table on the front panel shows the number to be set with the knobs. The number to be set is read by crossing the FFD-SID value in use with the cassette size in cm on inches.

i.e. at 90 cm FFD(36" SID) and using an 18 cm (7") cassette size, the field to be set would be 32.

inch cm	36" 90	40" 100	72" 180
5"/13	23	21	11.5
7"/18	32	29	16
10"/24	43	39	22
12"/30	53	48	28
14"/35	61	55	31.5
16"/40	70	63	36
17"/43	75	68	39



C) SPECIFICATIONS:

- Maximum protection against radiation leakage: 125 kVp - 4mA
- Field coverage a 90 cm FFD (SID): min. 0x0cm $\pm 1\%$ FFD
max. 43 x 43 cm - $\pm 1\%$ FFD
- Indicator precision corresponds to the X-ray field with tolerance less than 2% of the FFD (SID) used
- Inherent filtration, Al. Equivalent: 2.0 mm. minimum (1mm optional)
- Lamp power requirement: 24 volts DC/AC 50/60 Hz 5A – 12V optional
- Lamp ON time ≈ 30 seconds
- Lamp type: OSRAM HLX -100W – 24V
- Lamp support Z05.905/3442
- Weight: 3,5 Kg (9lbs)
- Classification EN 60601-1 par. 5
- Protection against electric hazards: **"Class I"** equipment
- Protection against direct and indirect contacts: **Type B** equipment with applied parts.
- Protection against water see page : **"Common equipment"**
- Safety of operation in the presence of inflammable anesthetics with air or oxygen or nitrous oxide: **Equipment not suited to application in the presence of inflammable anesthetic mixtures containing air or oxygen of nitrous oxide..**
- Operation conditions: **Equipment for continuous operation at intermittent loads .- See Operation Instructions on page H—1.**

Should label data on the collimator not correspond to the specifications herein, inform Advantech of the non-conformity.

Verifications of the specifications are to be performed according to the Standards relating to specified equipment.

Included with the collimator :

- Instruction Manual
- Retractable measuring tape shows the Focus Film Distance (FFD - SID).
- RO-198: Focus/skin RO spacer to keep the patient at a safe distance.

Optional:

- RO002: Mounting spacers 1.5 mm (0.05") thick, steel (to increase focus-to-collimator fixing plane distance).
- Tube port mounting flanges:

MODEL R72

- RO 181 - fixed flange, 10mm thickness
- RO 199 - rotating $\pm 90^\circ$, stop at 0° , thickness 10mm.

Symbols

SYMBOLS	DESCRIPTION	NO.	RIF.CEI
	Alternating Current	01-14	417-IEC 503
	Continual/Direct current	01-18	417-IEC 5031
	Both direct and alternating current	01-19	417-IEC 5033
	Protective earth	01-20	417-IEC 5019
	Positive polarity	01-27	417-IEC 5005
	Negative polarity	01-28	417-IEC 5006
	Input	01-36	417-IEC 5034
	Output	01-37	417-IEC 5035
	Remote Control	01-38	-
	Manual control	01-45	ISO 7000- 096
	Automatic control (closed loop)	01-46	ISO 7000- 0017
	Iris diaphragm: open	01-69	417-IEC 5323
	Iris diaphragm: closed	01-70	417-IEC 5324
	Attention, consult accompanying documents	03-02	IEC 601-1
	Radiation filter or filtration	04-51	417-IEC 5381

MODEL R72

SYMBOLS	DESCRIPTION	NO.	RIF.CEI
	Light indicator of the radiation field	04-54	417-IEC 5384
	Beam limiting device: open	04-55	417-IEC 5385
	Beam limiting device: closed	04-56	417-IEC 5386
	Beam limiting device with separate opening of the shutters	04-57	417-IEC 5387
	Beam limiting device with separate closing of the shutters	04-58	417-IEC 5388
	Type B unit		878-02-02
	Caution Laser Radiation		60825-1

COMPATIBILITY WITH X-RAY TUBE HOUSING ASSEMBLIES:

Compatibility is determined by the ability to comply mechanically with the dimensional drawing on Figure 1 page P—1; that the tube housing assembly must have a minimum inherent filtration of 1 mm. Al. equivalent and a maximum radiation leakage of 50 mr/hour measured at one meter from the source when operating at its leakage technique factors (125 kVp at 4 mA). Source values (tube housing-collimator) must not be less than 3mm Al for filtration and must never exceed 100 mR/hr for radiation leakage.

D) MOUNTING THE COLLIMATOR TO THE X-RAY TUBE:

WARNING

CAREFULLY FOLLOW THE MOUNTING INSTRUCTIONS AND MAKE SURE THAT THE COLLIMATOR IS CORRECTLY ASSEMBLED. INCORRECT MOUNTING COULD BE DANGEROUS: IT COULD CAUSE THE COLLIMATOR TO FALL OR TO OPERATE INACCURATELY

1. Determine the distance from the focal spot to the tube port face from the x-ray tube or generator literature.
2. Subtract the resulting distance from 70 mm (2,75") and determine how many 1.5 mm (0.05") spacers combined with the thickness of the mounting flange will be required to make up the difference. See Figure 4 on page P—4.
3. The outer face of the collimator mounting flange must be at 70mm from the focal spot. Allowable tolerance is 1 mm. (0.039"). - see Figure 4 on page P—4
4. Select four bolts of suitable thread (M6) and of such a length that they protrude through the flange and spacers far enough to engage at least 5 threads into the tube port face. Securely bolt the flange to the tube port face.
5. Remove the cover by unscrewing the four M3 screws located on the lower side of the cover.
6. Unscrew the four mounting and centring adjustment Allen screws M6 until the four tongues are withdrawn from the collimator top opening; see Figure. 1 – page P—1.

Note: when unscrewing the Allen screws that control the tabs do not use force exceeding 0,55 Nm

7. Place the collimator on the flange. Tighten the four mounting screws equally until the collimator is held firmly on the flange (0,55Nm max), see Figure. 1 – page P—1.
8. Check to see that the distance from the collimator housing to the mounting flange is equal in all directions and that the collimator face is parallel to the axis of the table.
9. Repeat the alignment if necessary.

E) ELECTRICAL POWER CONNECTION:

CHECK ON THE COLLIMATOR LABEL THE VERSION SUPPLIED.

WARNING

COLLIMATOR SUPPLY IS NOT PROTECTED BY A FUSE. CHECK THAT THE COLLIMATOR IS PROTECTED BY AN EXTERNAL FUSE PRIOR TO CONNECTION.

FUSE REQUIREMENTS: **4A DELAYED FOR THE 24V VERSION**
 8A DELAYED FOR THE 12V VERSION

CABLES AND TERMINALS USED FOR THE INTERNAL CONNECTION OF THE COLLIMATOR MUST BE SUITABLE FOR OPERATION AT TEMPERATURES OF 70° C AND COLLIMATOR CURRENT ABSORPTION.

Collimator supply must conform to MDD 93/42

Power supply connection:

- Unscrew the 4 screws on the lower portion of the cover; remove the cover.
- Connect the the cables to the terminal board contacts M3 (+Vcc) e M5 (0V)
 - Refer to the timer board diagrams on pages P—6, P—7, P—8.
- Connect the earth cable to the appropriate screw marked by the symbol: 
- Remount the cover.

WARNING

INCORRECT POWER SUPPLY COULD DAMAGE THE ELECTRONIC TIMER AND/OR THE LAMP.
SUPPLY TO THE QUARTZ IODIDE LAMP AND TIMER MAY BE EITHER IN ALTERNATE CURRENT OR DIRECT CURRENT - IN THE LATTER CASE MAKE CERTAIN THE POLARITY IS RESPECTED.

F) COLLIMATOR CALIBRATION:

WARNING:

THE FOLLOWING PROCEDURES REQUIRE THAT X-RADIATION BE PRODUCED. TAKE ADEQUATE PRECAUTIONS TO SEE THAT NO PART OF THE HUMAN BODY IS EXPOSED TO X-RADIATION, DIRECT OR INDIRECT.

1. Collimator to Focal Spot Alignment (Primary shutter Cut-off).

Inspect the four images of the four collimator shutters which form the edges of the x-ray field. A definitely indistinct edge indicates that the primary shutter, close to the focal spot, is the one forming the line, rather than the outermost shutter. No correction is possible, contact the manufacturer.

NOTE: The heel effect will cause the field toward the cathode to be slightly less sharp than on the other three sides. This is normal and cannot be corrected by adjustment. In addition, an x-ray tube of 12 ° or less target angle will produce an asymmetrically shaped field when a large field size is used at short FFD (SID), because of anode cut-off effect. This is normal and may not be corrected by adjustment.

2. Centering the x-ray field with the light field

Place a 35x43 cm. (14x17") cassette on the table top or other flat, horizontal surface and **position the x-ray tube/collimator assembly with the focal spot at 1 meter (40") above and with the x-ray beam perpendicular to the cassette surface.** Do not use equipment scales for reference, but measure the distance from focal spot to cassette surface.

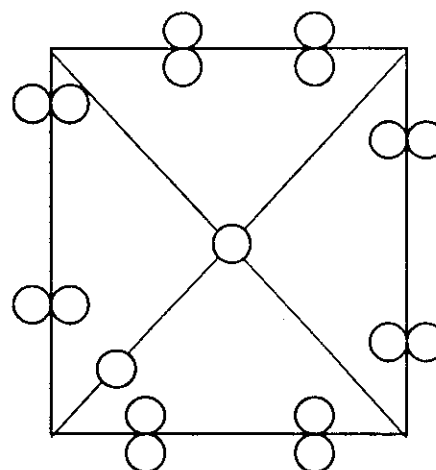
Note:

if one meter FFD (SID) cannot be obtained, use the obtainable FFD (SID) that is closest to one meter and calculate the measurement tolerances as the appropriate percentages of the distance.

If the x-ray beam cannot be oriented vertically, then make provision by using clamps, masking tape, etc. as required to place the test objects and image receptor at the specified FFD (SID) and perpendicular relative to the x-ray beam as described in the following procedures.

Use the collimator light to center the cassette in the field.

- Mark the location of the cassette with masking tape or other means so that it may be removed and replaced in the same position.
- Place white paper on top of the cassette to provide maximum contrast for the light field.
- Set the collimator to provide a field size of 30x30 cm. (12x12") at one meter (40").
- Activate the light field and use it to position 18 coins as shown in the diagram.
- Position each pair of coins touching one another so that the inner coin is lighted as much as possible and the outer coin is lighted as little as possible.
- The points of tangency will define the edges of the light field. Place the extra two coins, one in the lower left corner, which will provide the means for adjusting the film, the second in the center of the light field. To find the center draw two diagonals across the light field, the meeting point will determine the center.
- Set the technique factors at the x-ray generator to produce a density of about 1 (about 50 kVp, 5 mAs).
- Make an exposure. Remove the cassette and process the film. Use the test film to check the alignments: described in the following paragraphs.



Light field to x-ray Field Alignment.

EN 60601-1-3 par 29.202.9 - CFR 21 Sub-chapter J 1020.31(d)(2)

Misalignment of the light field to the x-ray field in either the X (cross table) or Y (long table) direction must not exceed 2% of the FFD. In this case, it would be less than 20 mm (0.78"). If the test film shows that the light field (shown by the shadows of the markers) matches the x-ray field (shown by the shadow of the collimator shutters) to within the diameter of one marker and, if the diameter is less than 20 mm then alignment complies with the regulations.

Greater precision is possible. The recommended maximum deviation is one fourth. You are urged to adjust for the greatest obtainable degree of congruency.

If misalignment is detected in both X and Y directions, check that the spacing from the focal spot to the collimator mounting surface is 70 mm. ± 1 mm. (2.75" ± 0.039 "). If the spacing requires adjustment, repeat the test film exposure after the adjustment.

If the collimator mount spacing is correct, but adjustment is still necessary, do not move the collimator relative to the x-ray tube, but proceed as follows:

- Place the test film on the face of the cassette over the white paper and place the cassette in the position originally marked.
- Check the correct position of the film by the shadows cast by the markers.

MODEL R72

- Using the images of the collimator shutters as the reference for the shape and size of the x-ray field, adjust the light field to match.
- To move the light field in the cross table direction, unscrew the 4 screws on the lower portion of the cover and remove the cover. Loosen the locking screws sufficiently to permit turning of the adjuster cam and allow mirror positioning, (Figure 2 page P—2).
- Lock the fixing screw and cam after adjusting the mirror position, and replace the cover.
- Before moving the light field longitudinally, remove the cover and the dissipator

WARNING: DO NOT IMMEDIATELY TOUCH THE DISSIPATOR WITH YOUR FINGERS IT COULD BE HOT AND CAUSE SEVERE BURNS.

- Loosen the two lamp-support fixing screws and using the hexagonal screw on the side of the lamp, adjust the lamp to make the two fields coincide (Figure 3 – page P—23)

DO NOT TOUCH THE LAMP, THE SOCKET, OR THE LAMP BRACKET WITH YOUR FINGER. THEY CAN BE VERY HOT AND CAUSE SEVERE BURNS.

Do not touch the lamp with your fingers, even when it is cold. Oil from your skin will cause the lamp to crack and possibly explode. If you have touched the lamp, wash off the surface with alcohol, then handle the lamp with a piece of paper.

- Tighten the 2 four screw fixing the lamp support.
- To adjust brightness around the edges of the light field, loosen the screws fixing the screens to the lamp holder and by using the Allen screws move screen to obtain the required adjustment. - See Figure 3 page P—33
- Tighten the screws of the screens.
- Repeat the test exposure after adjustment.

Field Size Indication Adjustment.

Regulations state that collimators must indicate the size of the x-ray field at the FFD (SID) in use to within 2% of that FFD.

1) Shutter Dial Pre-Adjustment:

- Rotate the two control knobs to completely close both sets of shutters.
- Use the field light to ascertain that the shutters are in fact closed.
- Check that each indicator is precisely over the dial line marked CLOSED.
- If the indicators read "0" when the shutters are closed, all the other dial indications will prove to be correct.

2) Shutter Dial Calibration:

- Measure the x-ray size field shown on the test film.
- Adjust the Light field to the same dimension and read the measure on the dial.

MODEL R72

- If the reading is not within tolerance, adjust the indicator .
- Using a wrench n. 2. loosen the Allen screw placed on the side of the knob.

Crosshairs, Alignment

- Activate the light-field.
- Turn the control knobs to adjust the light-field to a narrow line; each direction in turn.
- Check that the crosshair line is centered in the narrow light line in each direction.
- If adjustment is required, remove the cover and loosen the four screws securing the plastic panel to the collimator and position the plate to center the cross lines in the light lines.
- Tighten the four screws and replace the cover.

Friction Brake Adjustment

- Friction is adjusted for a shutter movement force of 20 Cnm.
- If a shutter control is too loose and does not hold position, or is too tight and is difficult to turn, adjust the appropriate friction brake to obtain the optimum friction - See Figures 3 and 4 on pages O-3 and O-4 respectively.

G) Compliance verification

To indicate compliance with 21 CFR, sub-chapter J, part 1020 of Performance Standard it is necessary for the assembler to perform a series of tests.

Description of tests methods are illustrated in this chapter but factors, as experience, availability of equipment and tolerances on compliance are referred directly to the Safety Standards covering Electromedical equipment.

1. MINIMUM FILTRATION REQUIREMENT – BEAM QUALITY (HVL)

WARNING:

The following procedures require that x-radiation be produced. Take adequate precautions that no part of human being is exposed to x-radiation, direct or indirect.

The above HVL requirements can be met if it is demonstrated that the aluminium equivalent in the primary beam is not less than that shown in the following table:

Designed operating range (kVp)	measured operating potential (kVp)	minimum HVL (mm. of Al) X-Ray System
Below 50	30	0.3
	40	0.4
	50	0.5
From 51 to 70	51	1.2
	60	1.3
	70	1.5
Above 71	71	2.1
	80	2.3
	90	2.5
	100	2.7
	110	3.0
	120	3.2
	130	3.5
	140	3.8
	150	4.1

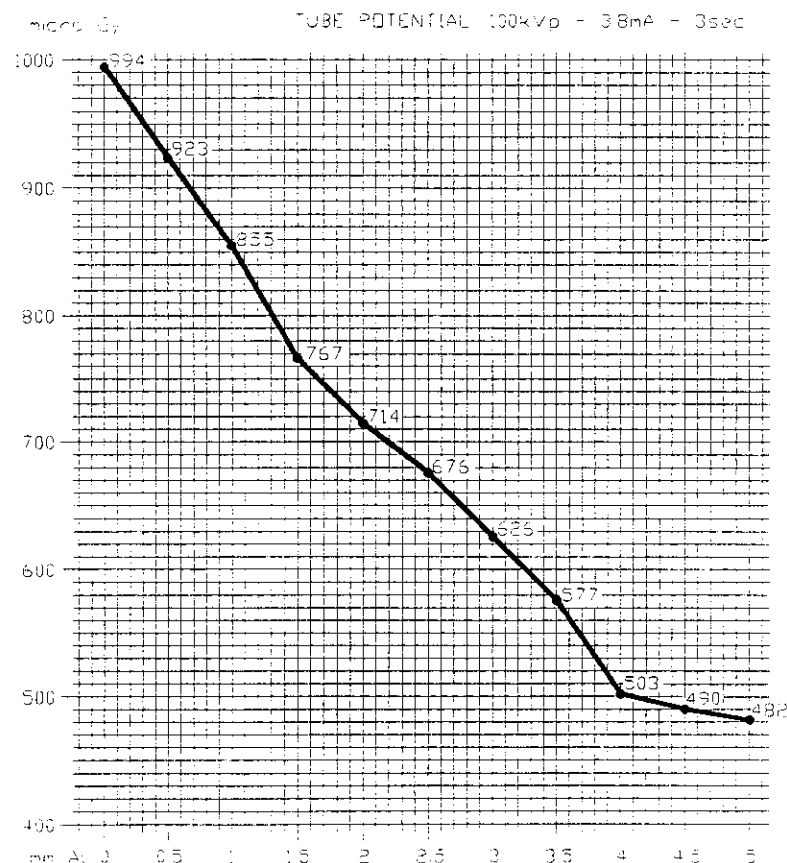
Determine the total inherent filtration in Aluminium equivalence in the primary beam (x-ray tube and housing, beam limiting device and any additional filtration in the system). If the total inherent filtration cannot be seen, than the HVL obtained with the following procedures must be compared with those specified in the above table. The HVL in millimetres of aluminium in the system under test must be greater than or equal to the values shown in the above table.

- a. Direct the central x-ray beam perpendicular and in the center of a RAD-Check instrument. Determine the exact distance from the x-ray tube focal spot to the window of the

MODEL R72

collimator (275 mm - 10.8"). Place the input area of the RAD-CHECK at an equal distance from the collimator window. Collimate the beam to an area slightly larger than the detector.

- Select a tube potential which is the highest in the kVp range, with no added filtration in the beam make an exposure and record the reading. Using the type 1100 Aluminum Alloy (as given in "ALUMINUM STANDARDS AND DATA" verification of compliance), tape the increments of filtration to the window of the collimator. Make an exposure and record the reading for each total thickness of filtration as indicated in the above table. The information contained in the above table was extracted from the Code of Federal Regulations FDA 21 1020.30 (m)
- Plot the exposure readings (log scale) versus the total added filtration thickness on semilog paper, see sample hereunder. Verify that HLV values in the useful beam for a specific tube potential is not less than the values shown in the above specified table.



A quick-check confirmation of the minimum filtration requirement at a particular kVp can be made as follows:

MODEL R72

At a pre-selected kVp, record an exposure reading with no filtration, then tape a total of 2.5 mm of aluminium on the collimator window. Repeat the exposure with the same tube potential and record the value.

The minimum filtration requirement has been met if the second exposure is greater than or equal to one-half of the first exposure.

2. VISUAL DEFINITION OF X-RAY VERSUS LIGHT FIELD

Applicable Chapter: **COLLIMATOR CALIBRATION:** paragraph 1. Light field to x-ray Field Alignment, page F—3

3. FIELD SIZE INDICATION

Applicable Chapter: : **COLLIMATOR CALIBRATION:** paragraph **Error! Reference source not found.** page F—3

4. CROSSHAIR ALIGNMENT

Applicable chapter: **COLLIMATOR CALIBRATION:** PARAGRAPH 2 **ERROR! REFERENCE SOURCE NOT FOUND.** PAGE F—5

5. LIGHT FIELD ILLUMINATION INTENSITY

- a) When a light field simulating the X-Ray field is used the illumination provided at 100 cm. cannot be less than : 250 lux (21 CFR 1020.31 (d) (2) (ii))
- b) Place the Focus of the X-Ray tube at 100 cm. from the table top where the light field as been projected. Open the collimator's shutters to assure that each quadrant of the light field is larger than the measuring area of the photometer.
- c) Check that the voltage specified by the manufacturer is applied to the lamp, make certain that all surfaces in the light beam are clean and unobstructed.
- d) Place a photometer capable of reading up to 250 lux in the center of each of the four quadrants of the light field.
- e) Turn on the light beam and read the light intensity, subtract to it the ambient lighting, previously determined.
- f) Verify that the average illumination is higher than 250 lux. Record the measured lux and all data concerning the instrument and the voltage used.

H) OPERATION INSTRUCTIONS

WARNING

PROLONGED LIGHTING WITHOUT ALLOWING THE LAMP TO COOL CAUSES THE COLLIMATOR TO OVERHEAT IN THE AREA NEAR THE LAMP - THE MAXIMUM LIMIT ADVISED IS 5 SUCCESSIVE LAMP OPERATIONS.

THE OPERATE MUST AVOID OVERHEATING THE COLLIMATOR AND CARE MUST BE TAKEN NOT TO SCORCH HIMSELF OR THE PATIENT

The collimator is normally operated by activating the pushbutton on the lateral panel to switch the light field ON

Light ON time is adjustable from 15 to 45 seconds via the trimmer on the electronic board. The factory setting is ± 30 s.

The collimators has been designed to operate as follows:

- Supply constantly connected during operation of the equipment.
- Quartz iodide lamp ON time for the light field at about 30 s.
- A normal ON/OFF cycle may be repeated twice = 1 minute, followed by 4 minutes OFF.

Light/x-ray field, adjustment:

- Follow the tags of the scale on the front panel and the knob index. See the Table con the collimator.
- Rotate the knobs to select the field at a set FFD.
- Do not force the knobs.
- The collimator is ready – x-rays may be performed.

I) ROUTINE MAINTENANCE

To ensure constantly safe performance of the collimator and its compliance with applicable regulations, a maintenance program is indispensable.

It is the Owner's responsibility to supply or arrange for this service.

Cleaning recommendations

- The collimator housing must be cleaned as prescribed by the sanitary regulations followed by the operator.
- Disconnect supply
- Use non abrasive cleaning products. Care must be taken to prevent liquid from entering the collimator. **N.B.** the collimator cover is not watertight.
- Do not re-apply power if inflammable liquids have leaked into the collimator. See the following Maintenance Instructions.

Recommended maintenance programme:

Advantech suggests a yearly servicing programme. However shorter intervals are advisable when the collimator is subject to heavy workloads.

Re-calibration of the collimator will be necessary whenever the x-ray tube is changed or at each substitution of the lamp used to simulate the light field. Calibration procedures must be performed as described in this manual - page F—1.

1. Remove the covers and panels from collimator. Inspect the moving parts for signs of wear or damage.
2. Check the electric system and substitute parts that show wear.
3. Check the Lexan panel and substitute if necessary.
4. Clean the collimator with a soft cloth paying particular attention to the Lexan window. **Do not** use abrasive or inflammable cleaning products.
5. Sparingly lubricate the moving parts using graphite oil. Wipe away all excess oil.
6. Remount the cover.

J) TROUBLESHOOTING

Should the Collimator become faulty do not use it until completely repaired. The use of a faulty collimator might impair the safety of the operator and patient.
Before returning the collimator to Advantech for repair, please make sure that it isn't one of the following problems to cause the fault

PROBLEM	CAUSE	SOLUTION
The lamp fails to switch on	The collimator is not supplied correctly	Check supply/ Tension/current/polarity/ Fuses
	The lamp is faulty	Check filaments - substitute if necessary. See Substitution Of The Lamp On Page K—1
	Timer is faulty	Check supply to the timer. If there is no output tension, substitute the timer. See Substitution Of The Electronic Timer on page K—1
	ON-Off button is faulty	Check contacts - substitute if necessary
The collimator is not centered:	Mirrors are not positioned correctly	See Error! Reference source not found. Page Error! Bookmark not defined.. See COLLIMATOR CALIBRATION: page F—1
Incorrect field dimensions	Knobs are off index	Loosen knob screws and adjust - See Field Size Indication Adjustment. page F—3
Light edge definition is not good.	Light screen not aligned correctly	See Figure 3 page P—33

K) SUBSTITUTIONS, DISASSEMBLY, TRANSPORT

Substitutions:

The following operations must be performed by technically prepared and authorised personnel.

See Figure 5 - Parts Breakdown on page P—5

Substitution of the lamp:

WARNING: DO NOT IMMEDIATELY TOUCH THE DISSIPATOR WITH YOUR FINGERS IT COULD BE HOT AND CAUSE SEVERE BURNS.

WARNING: DO NOT TOUCH THE LAMP, THE SOCKET, OR THE LAMP BRACKET WITH YOUR FINGER. THEY CAN BE VERY HOT AND CAUSE SEVERE BURNS.

- Disconnect supply
- Remove the lower cover
- Remove the lamp protection dissipator.
- Carefully remove the faulty lamp.
- Substitute the lamp with an identical lamp (same V, W and filament power)
- Make sure that the pins are completely inserted in the lampholder
- Check on light field/x-ray field correspondence
- If necessary remove the lamp, rotate it 180° axially and re-insert.
- Remount the disconnected items

Substitution of the electronic timer (versions featuring the timer):

- Disconnect supply
- Remove the lower cover.
- Remove the two screws holding the electronic timer.
- Identify the cables and their position on the terminal board.
- Disconnect the cables from the terminal board.
- Install the new timer by proceeding in a reverse order; pay particular attention to the connection of the cables to the 6-way terminal board.

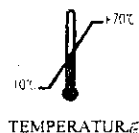
Disassembly

- Disconnect supply to the collimator.
- Disconnect the supply cables.

- Loosen the 4 fixing screws on the upper part of the collimator - **care must be taken not to let the collimator fall.**

Transport

- Suitable packing must be provided for.
- **Place the collimator in a plastic bag to avoid packing material from entering the collimator.**
- Use an appropriate box for transport or shipment taking care to protect the collimator from



FRAGILE
X-RAY EQUIPMENT

rough handling. This will avoid damage to the collimator from transport or shipment.

MODEL R72

Rev.A

L) SPARE PARTS:

NOTE: WHEN ORDERING SPARE PARTS, THE CLIENT IS REQUESTED TO SPECIFY THE MODEL AND SERIAL NUMBER OF THE COLLIMATOR CONCERNED.

RO 002	STEEL SPACERS, THICKNESS 1.5 MM
RO 181	MOUNTING FLANGE, FIXED TYPE, 10MM THICKNESS
RO 198	FOCUS-SKIN SPACERS
RO 199	MOUNTING FLANGE, ROTATING TYPE
RS 006	LAMP 100W 24V
RS 033	CERAMIC LAMPHOLDER
RS 063	TIMER FM338 24V
RS 092	LAMP 100W 12 V
RS 204	TIMER FM338 12V
RS 451	GREY KNOB + R72 INDEX
RS 533	LATERAL PANEL, LONG, AL. WITH INDEX SCALE
RS 534	LATERAL PANEL, CROSS, AL. WITH INDEX SCALE
RS 535	LATERAL PANEL, LONG, AL. WITH INDEX SCALE PLUS PUSHBUTTON HOLE
RS 536	LOWER COVER IN ABS
RS 537	UPPER COVER R72 STANDARD
RS 538	RETRACTABLE MEASURING TAPE
RS 540	ANTIDUST PANEL R72 (CSA)

Label:

MAXIMUM KVP:	110
MINIMUM INHERENT FILTRATION, MM, AL EQUIV:	2.0
SUPPLY VOLTAGE:	12 AC
LAMP TYPE:	HLX
MODEL #:	R-72/32-ET
SERIAL #:	946
DATE OF MFR:	(7/2) 545-3500
CERTIFICATION: THIS DEVICE COMPLIES WITH DHHS RADIATION STANDARDS 21 CFR, SUBCHAPTER J.	
HOBE SOUND, FL. 	
ADVANTECH SYSTEMS - METHUEN, MA	
978/794-8000	01844 U.S.A.

M) REPAIRS

- Return the collimator to Advantech At the customer's expense if the unit is out of warranty.
- Provide the collimator with a detailed description of the functional problems and/or faults. It is important to indicate whether a repair or a complete overhaul is required.
- Our Quality Control will test the collimator.
- If the repair involved is extensive, Advantech will contact the customer to advise on the repair or possible substitution.

N) END OF LIFE DISPOSAL

Your collimator contains materials which can be recycled and reused. Specialised companies can recycle your product to increase the amount of reusable materials and to minimise the amount of materials to be disposed of.

Please inform yourself on local regulations on disposal of your old set.

O) WARRANTY:

Advantech guarantees free of charge labour and replacement parts during a period of 12 months from the date of shipment of the material.

The Advantech warranty applies provided the product has been handled properly in accordance with its operating instructions and upon presentation of the original invoice indicating the date of purchase the model and serial number as well as other control documents originally supplied with the set.

The Advantech warranty may not apply if:

- the documents have been altered in any way or made illegible;
- the model or production number on the product has been altered, deleted, removed or made illegible;
- repairs or product modifications and alterations have been executed by unauthorised persons;
- damage is caused by misuse or neglect, incorrect installation or accidental damage including but not limited to lighting, water or fire.

In-warranty spares will be available only upon return to Advantech, at the customer's expense, of the parts considered to be faulty to assess the cause of the fault.

Defective material is to be sent to:

Advantech Imaging Systems, LLC
10861 SE Stern Lane
Hobe Sound, FL 33455 USA
Fax. 772-545-3500

Email: advantech@bellsouth.net

P) FIGURES, DIAGRAMS, TABLES

Rev. A

NOTE: SHOULD THE ELECTRIC DIAGRAM REQUESTED BY YOU DIFFER FROM THE STANDARD UNIT SUPPLIED – PLEASE SEE THE ATTACHMENTS.

Figure 1

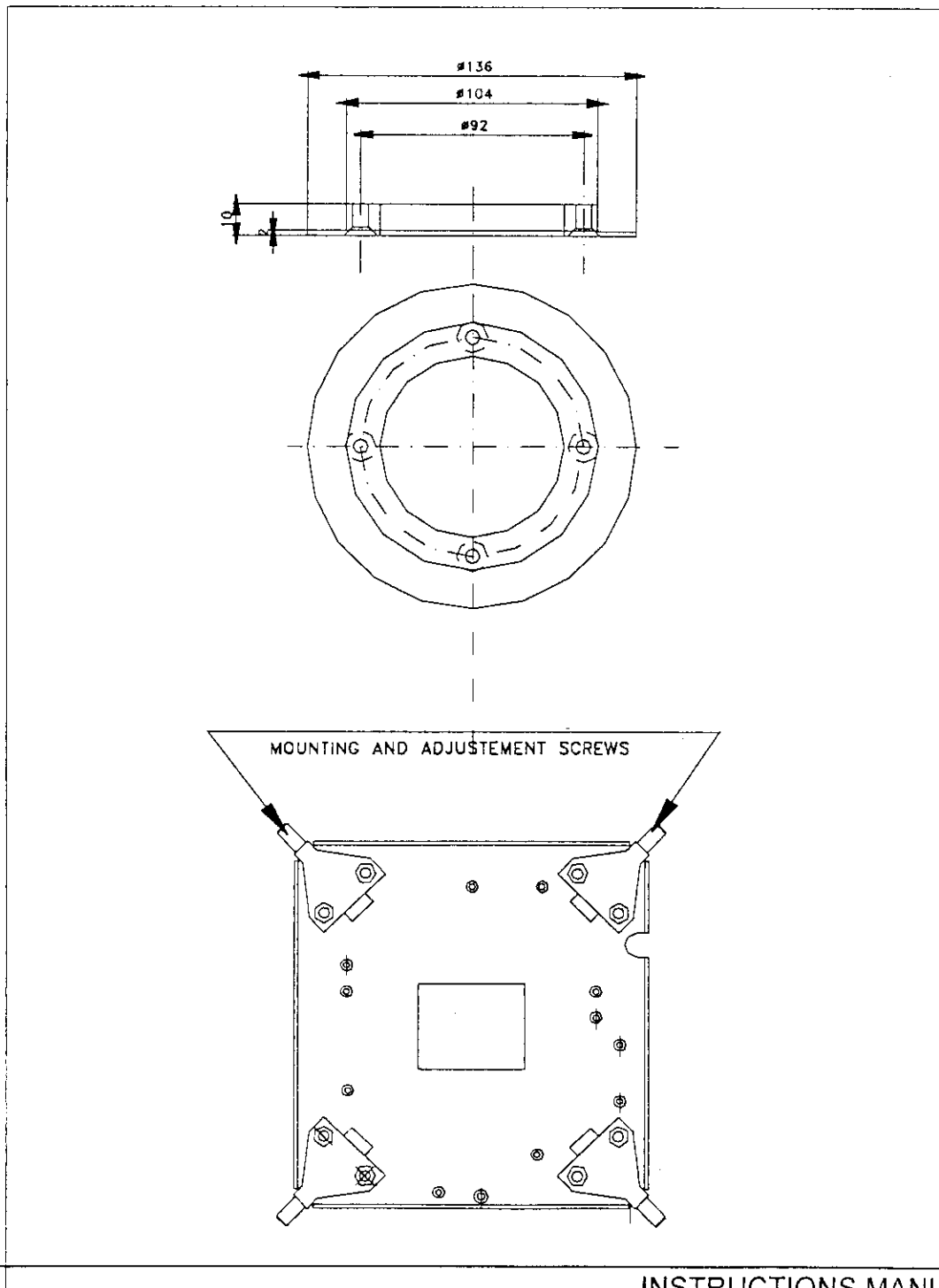


Figure 2

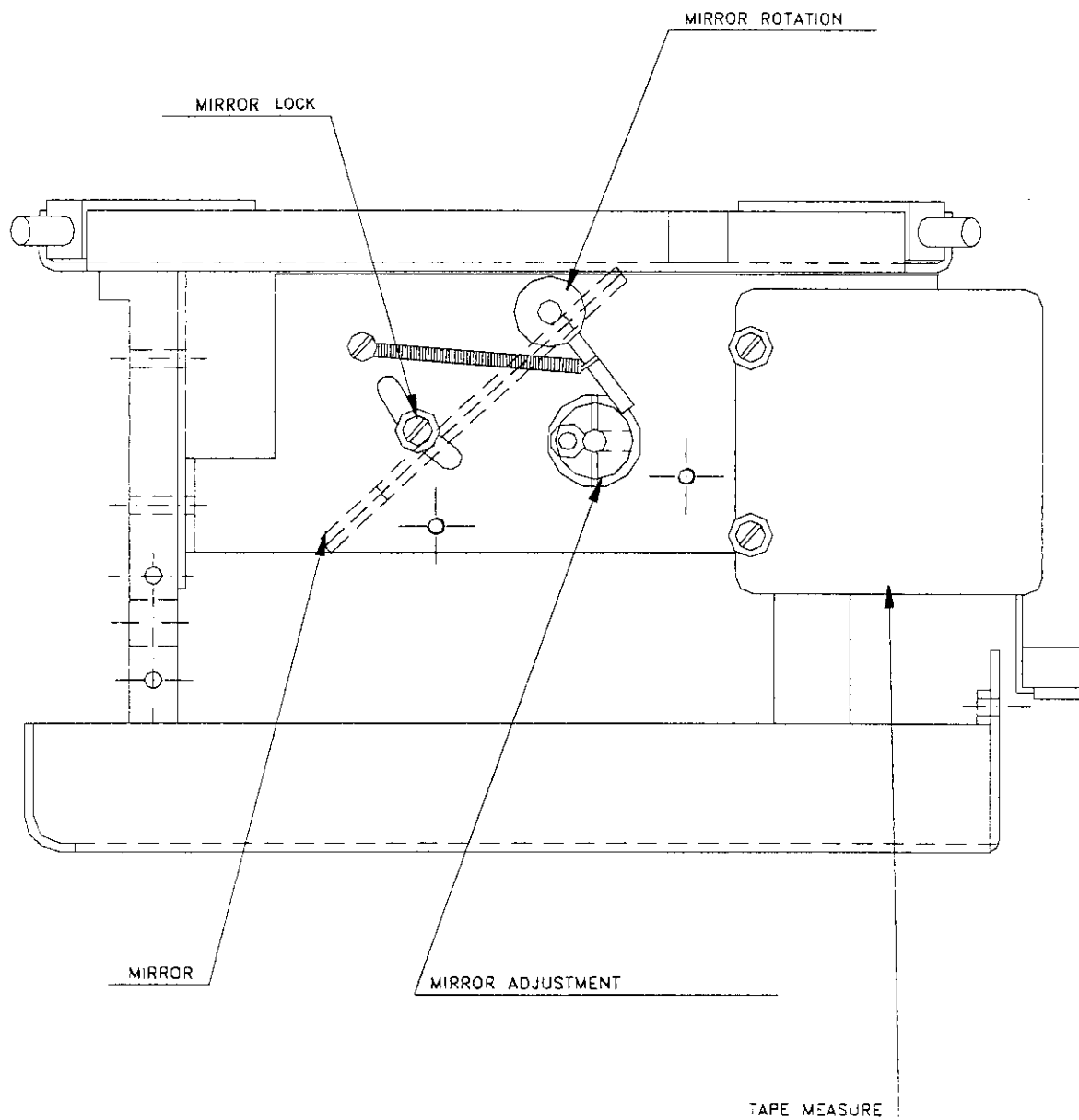


Figure 3

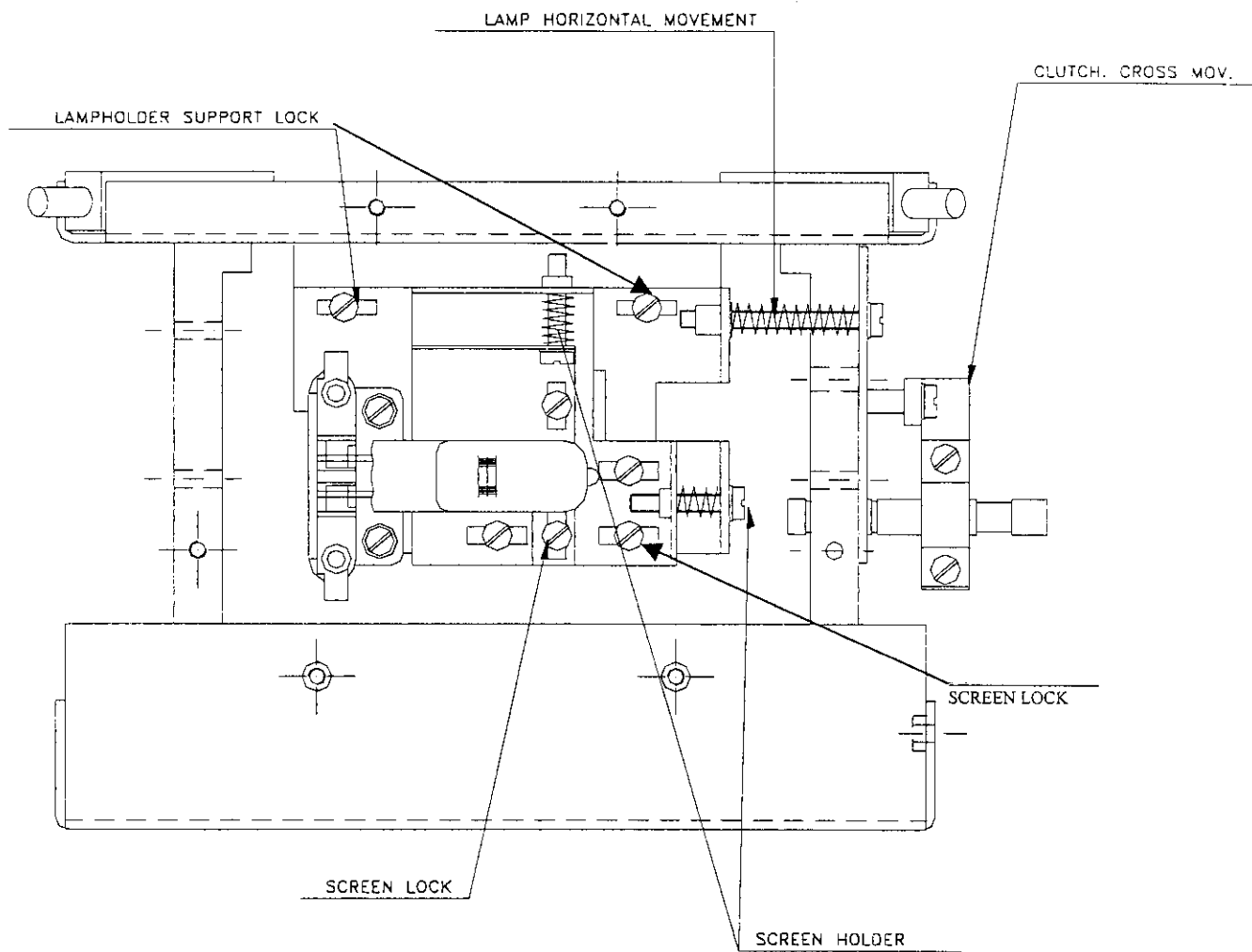


Figure 4

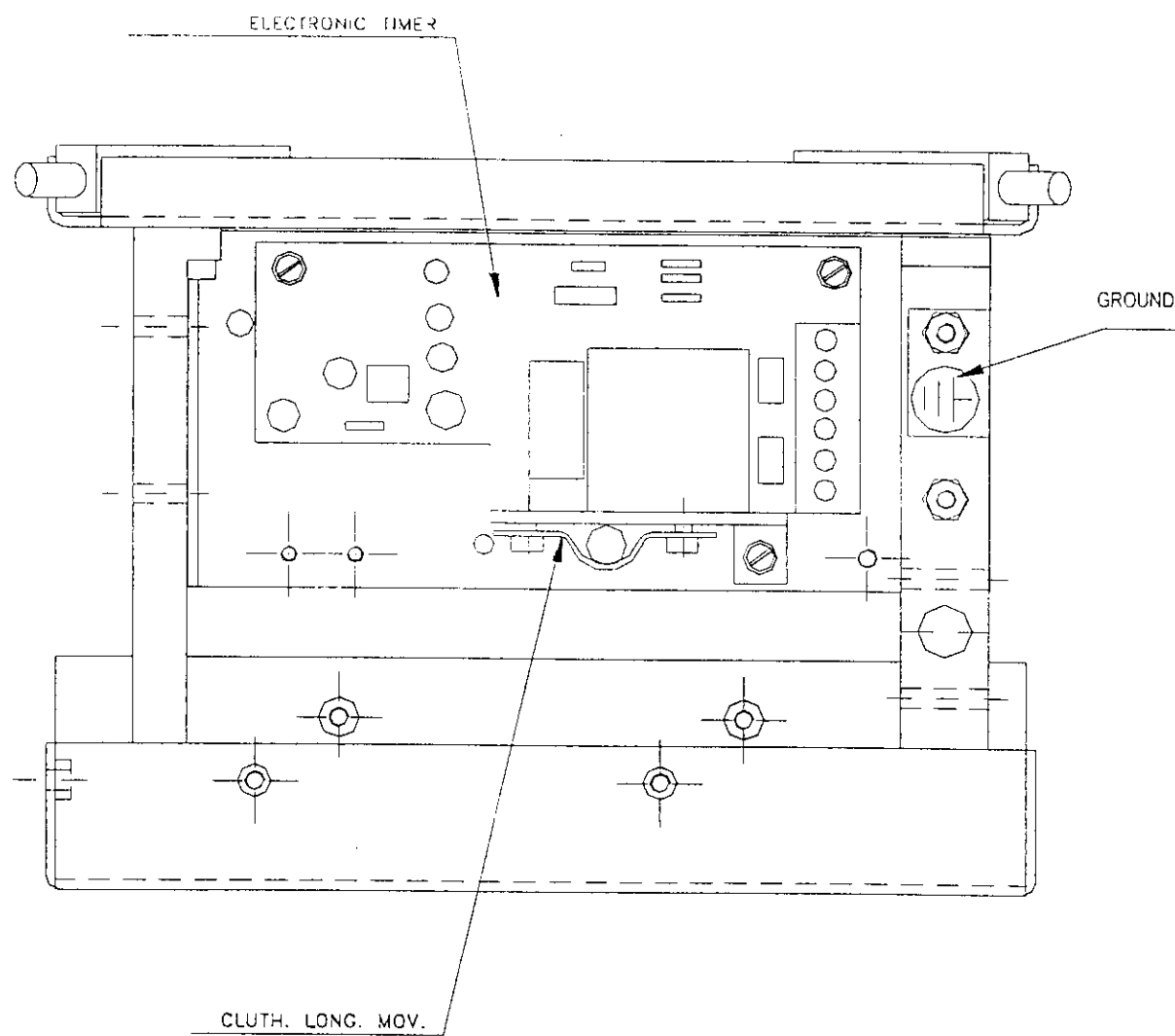


Figure 5 - parts breakdown

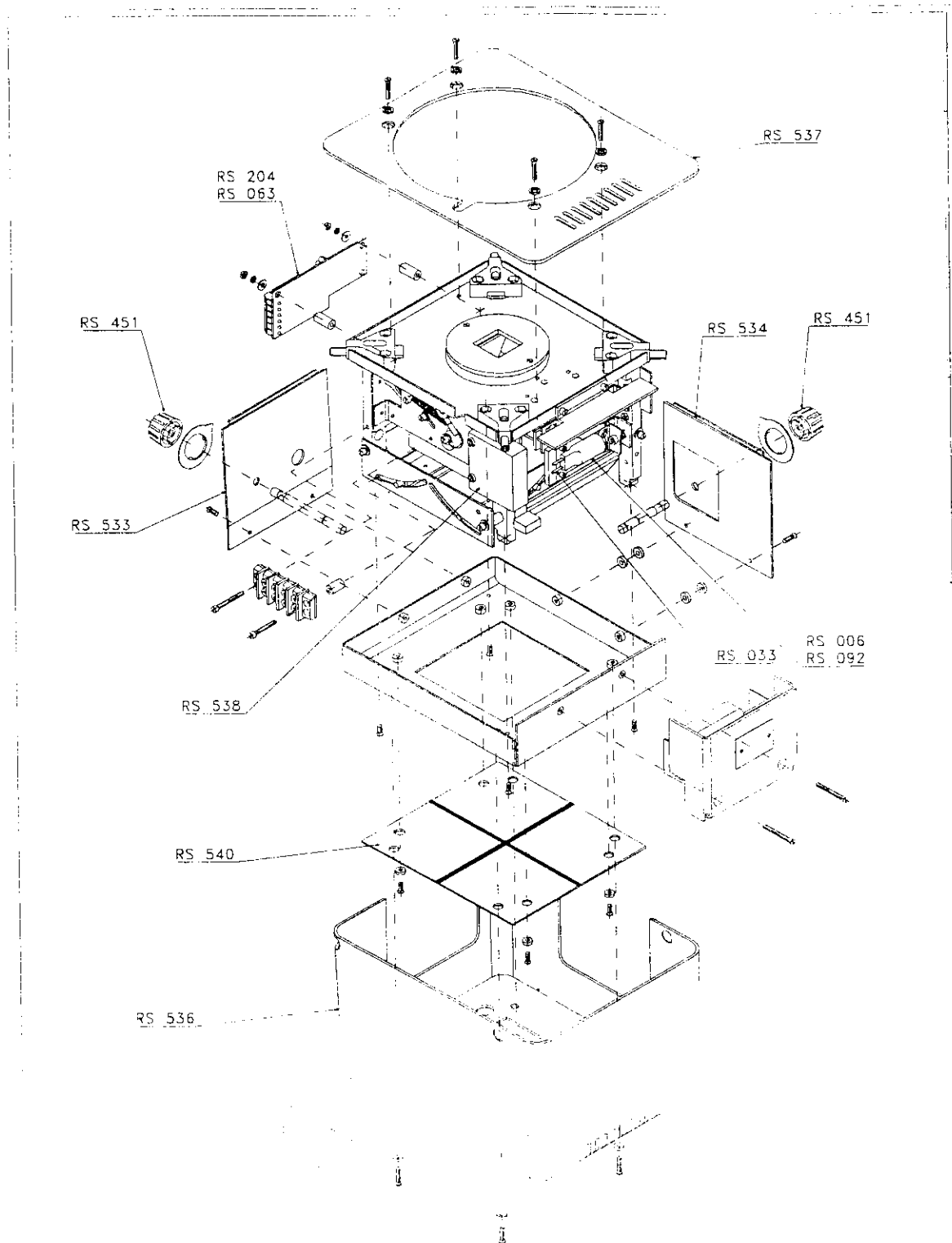
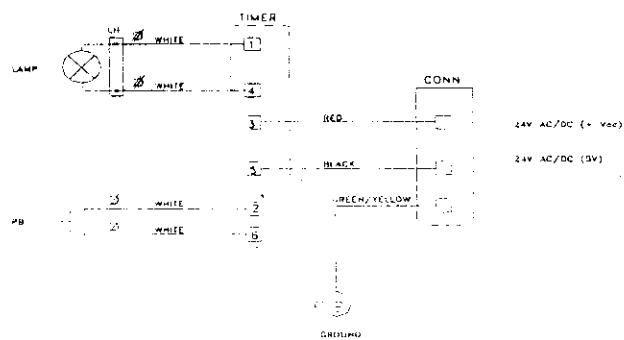


Diagram 1 -Electronic Timer Board FM338



ELECTRICAL WIRING
R 72

726007

Diagram 2 -Electronic Timer Board, Electric

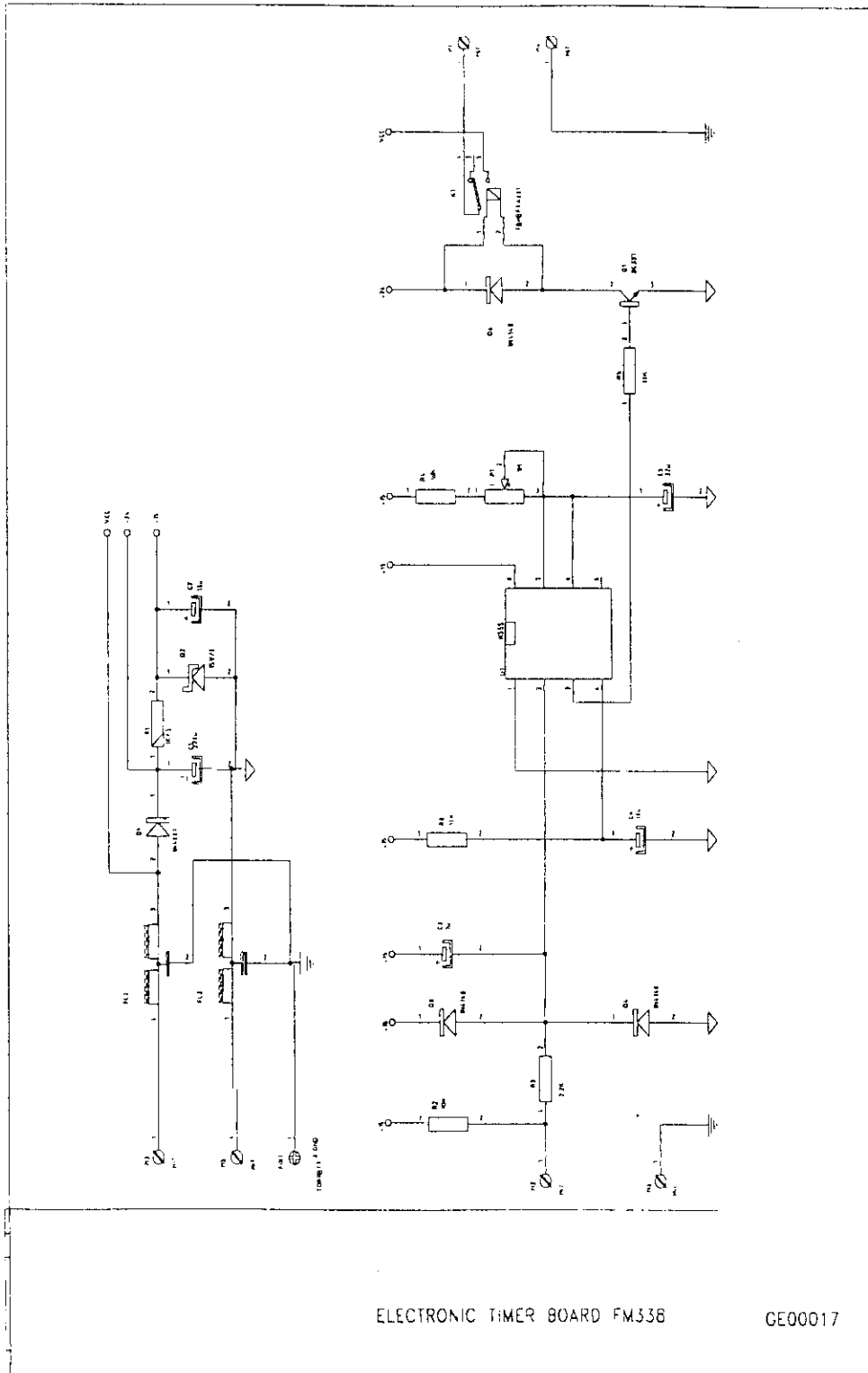
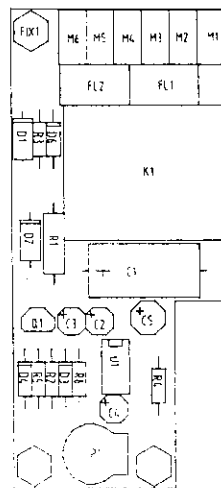


Diagram 3 – Board layout 24V



ELECTRONIC TIMER BOARD FM33B

GE00017

TABLE OF CONTENTS

*FORBWORD	Page 1
*WARNING	Page 1
SECTION I. PRODUCT DESCRIPTIONS	
** General Description	Page 1
** Features and Performances	Page 1 & 2
* Specifications	Page 2
** Compatibility	Page 2 & 3
** Name of Each Part	Page 4
SECTION II. INSTALLATION AND OPERATION	
*** Responsibility of Installer	Page 5
*** Electrical Supply Requirement	Page 5
*** Installation Method	Page 5 & 6
** Operation	Page 6
** Cares to be taken on Operation	Page 6
SECTION III. INSTRUCTIONS FOR MAIN ADJUSTMENT DEVICES	
*** Lamp Replacement and Adjustment Method of Lamp Filament Position	Page 6 & 7
*** Alignment Check and Adjustment Method	Page 8
*** Plastic Mirror Replacement Method	Page 9
SECTION IV. MAINTENANCE	
** Compliance Maintenance Schedule	Page 10
*** Circuit Diagram	Page 10

* marked : Common to Operators and Installers.

** marked : For Operators Only.

*** marked : For Installers Only.

FOREWORD

This manual is prepared to guide the use of "Collimax" Model D-180HS-G X-Ray Collimator. This manual provides explanations of the function, operation and maintenance procedures etc.

One who installs and or uses this collimator must read this manual with care to understand this product prior to installation and operation.

WARNING

"Collimax" Model D-180HS-G X-Ray Collimator is designed and constructed within the specifications imposed by DHEW and within practical limitations to provide protection against all unwanted x-radiation emissions. One who installs and or uses this collimator must be well acquainted with instructions in this manual pertaining to the proper use.

SECTION I. PRODUCT DESCRIPTIONS

General Description

This X-Ray Collimator is designed for such applications as shown in the "Specifications" of this manual and must be used with the x-ray tube to restrict and define the area covered by the x-ray beam and also to reduce stray radiation. The beam that is collimated by the 2 control knobs should cover the smallest area of the patient necessary to produce the required radiograph. The collimator that allows a stepless adjustment of a field size utilizes a light localizer to project a visible beam with coverage equivalent to the coverage of the x-ray beam.

Features and Performances

1. Provided with a push button timer to automatically switch off the lamp of light localizer in 30 seconds.
2. Equipped with special Ring Device by which the center of collimator is adjustable by ± 2 mm to align the center of visible beam with the one of x-ray beam, and yet the collimator can be self rotated.
3. The lamp of light localizer is easily replaceable with minimized error of the same lamp position and the lamp filament position can be easily adjusted.
4. Maximum shutter opening of collimator is less than 35 cm x 35 cm at SID 65 cm.
5. Minimum x-ray field size at SID 100 cm is less than 5 cm x 5 cm.
6. The average illuminance of light field at SID 100 cm is 180 lux or more.
7. The contrast ratio on the light field edges is 3.5 : 1 or more, which allows an easy identification of light field and its size.
8. Provided with calibration scales indicating the light field sizes at each SID which accuracy variance is within 2 % of SID.
9. The leakage radiation at SID 100 cm is within 50 mR/h.
10. The insulation resistance between source circuit and a grounding metal is 2 M ohm or more.

11. The electric resistance between a grounding terminal or a grounding metal and outer case is not more than 0.1 ohm.
12. The collimator can endure, for a minimum of one minute, AC 1500V between AC line terminal and a grounding metal.

Specifications

1. Applications: For general purpose mobile x-ray units, and special purpose radiographic unit designed for use with a fixed image receptor size at a fixed SID.
2. Maximum KVP: 125kvp.
3. Outer Dimensions: 182mm x 197mm x 140mm.
4. Net Weight: (approx.) 5.9kg.
5. Shutters Drive: By 2 manual control knobs.
6. Projection Lamp: Philips Type 7158 Halogen Lamp, 24V/150W rated, or an equivalent Halogen lamp of the same rating.
7. Power Supply to Lamp: AC 19V (under load), measured at lamp socket, or more.
8. Lamp Switch: Push Button Type 30 seconds Electronic Timer.
9. Minimum Line Current: 5.8A at AC 19V under load, or more.
10. Maximum Field Size: 35cm x 35cm at SID 65cm.
11. Minimum Field Size: Less than 5cm x 5cm at SID 100cm.
12. Min. Aluminum Equivalence: 0.4mm Al at 100kvp.
13. Installation Method: By installation of adaptor flange on tube housing with 4 bolts, and diagonal length of the 4 installation bolts is 92mm. Other installation methods are optionally available.
14. Tube Focal Distance: 60mm, as the standard tube focal distance, from tube focus to the bottom surface of adaptor flange, but adjustable between 60mm - 52mm by use of spacers that are supplied with each collimator.

Compatibility

This collimator is compatible and can be adopted for use with any x-ray tube (with tube housing) that meets all of the following factors.

1. Focal Distance of X-Ray Tube:
Adjustable between 60mm (standard) - 52mm from tube focus to the bottom of adaptor flange of this collimator by use of the spacers. For 60mm tube focal distance, the spacers are not used. For tube focal distance of less than 60mm, use the spacer(s) to obtain each correct tube focal distance in view of compliance with Performance Standard (e.g., 52mm: 2pcs. x 2mm thick spacers).

2. Installation Method:

By installation of adaptor flange on tube housing with 4 bolts, and diagonal length of the 4 installation bolts is 92 mm.
Other installation methods are optionally available but they must be consulted in advance with the manufacturer of this collimator.

3. Leakage Radiation:

Maximum leakage radiation from tube housing assembly must be within 50 mR/h at SID 100 cm.

4. Inherent Filtration:

Inherent Filtration of this collimator is 0.4 mm Al at 100 kVp.

5. Half-Value Layer:

Half-value layer of useful beam at a x-ray tube voltage must not be less than the values shown in Table I of (n) Beam Quality of Section 1020.30 under Performance Standard.

6. Applications:

For general purpose mobile x-ray systems, and special purpose radiographic systems designed for use with a fixed image receptor size at a fixed SID. Maximum tube voltage of those x-ray systems must be 125 kVp or less, in the output.

7. Power Supply to Collimator Lamp:

Loading voltage and maximum line current to collimator lamp must be AC 19 V or more and 5.8 A or more respectively, being measured at the lamp socket under load.

Note: Collimator lamp to be used must be Philips Type 7158 Halogen Lamp, rated 24 V/150 W or an equivalent Halogen Lamp of the same rating that meets the international standard (of same filament size and shape).

8. Others:

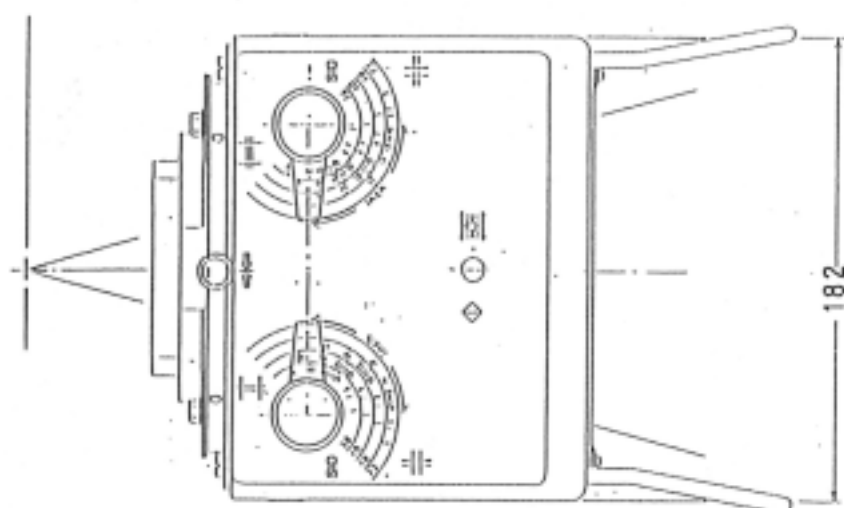
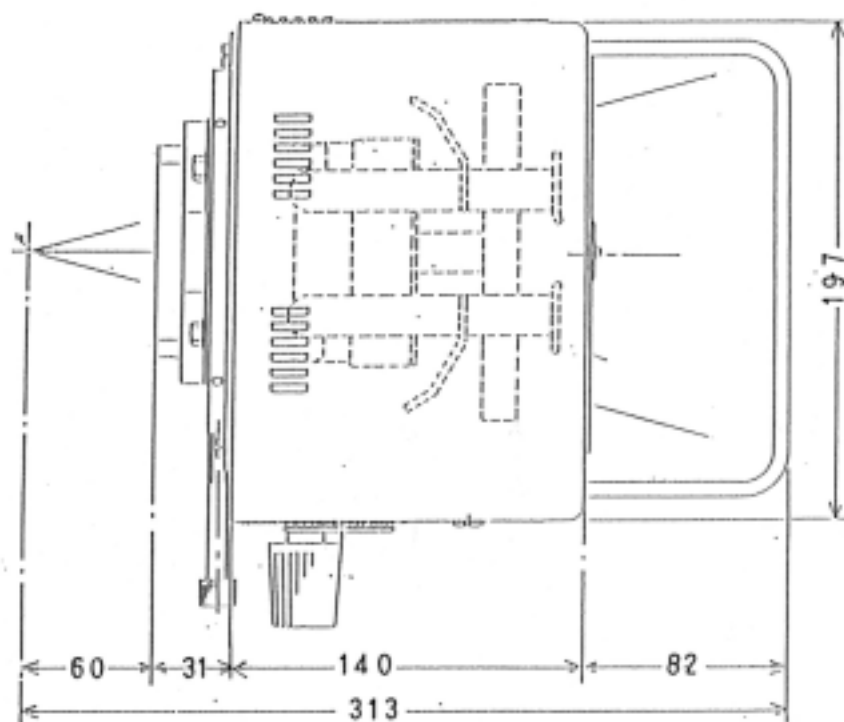
When collimator was combined with x-ray tube, D.S.A. (Diagnostic Source Assembly) must have illuminance of 180 lux or more at SID 100 cm, Contrast Ratio of 3.5:1 or more at SID 100 cm, and Misalignment (of light field with x-ray field) of not more than 2 % of SID.

Name of Each Part

See the drawing of next page.

Outer Appearance and Dimensions and Name of Each Part

-4-



SECTION II. INSTALLATION AND OPERATION

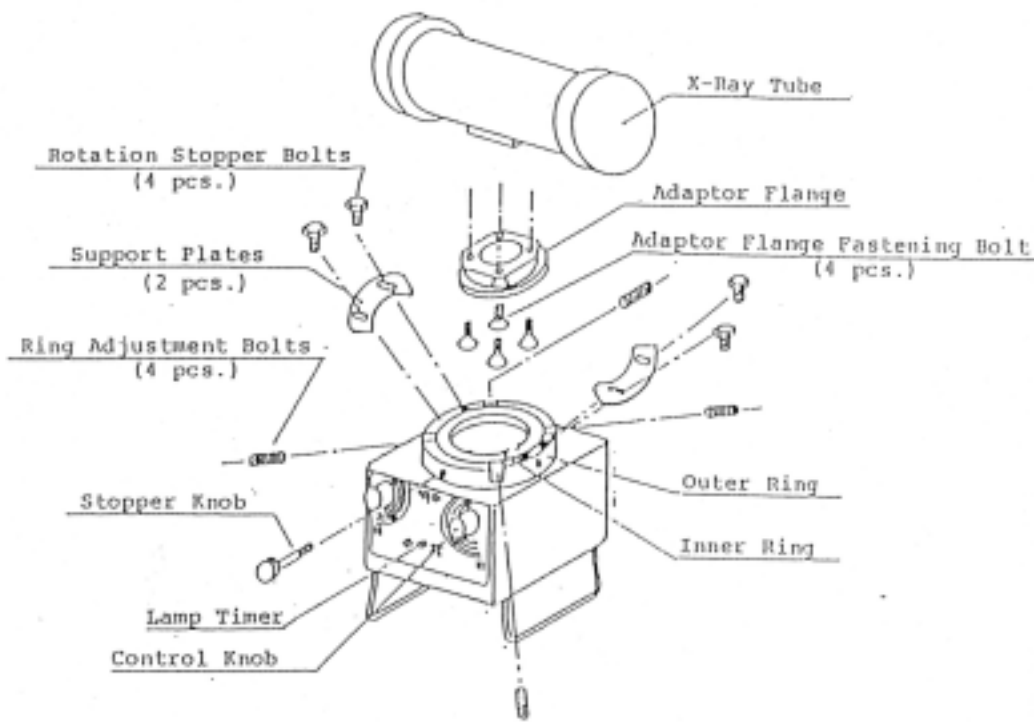
Responsibility of Installer

It is the responsibility of the installer to correctly install this collimator as instructed in this manual. The installer must certify that the x-ray equipment on which tube housing assembly the collimator was installed is in compliance with DHEW Regulations.

Electrical Supply Requirement

It is imperative that a sufficient power is supplied to the collimator lamp to obtain the specified voltage under on-load condition being measured at the lamp socket, to keep this collimator in compliance with DHEW Regulations.

Installation Method (see drawing as shown below)



1. Install the adaptor flange on tube housing assembly with 4 installation bolts.
2. Hold the collimator and place its Inner Ring over the adaptor flange, then fix the 2 Support Plates, temporarily, with the 4 Rotation Stopper Bolts.
3. Fasten Stopper Knob not to allow collimator to rotate.

4. Connect the power supply cord of lamp and push Lamp Timer to confirm that the lamp is illuminated.
5. Adjust collimator position with 4 Ring Adjustment Bolts so that the center of adaptor flange will be aligned with the center of the inner ring, then fasten firm the 4 Rotation Stopper Bolts.
6. Push Lamp Timer and make sure that light field can be collimated to a required size by operation of 2 manual control knobs.

Operation

1. Push Lamp Timer and confirm that light field is illuminated.
2. Adjust collimator position so that the centering cross mark of collimator is aligned with the center of an image receptor.
3. Collimate light field to the image receptor size operating the 2 manual control knobs.

Cares to be Taken on Operation

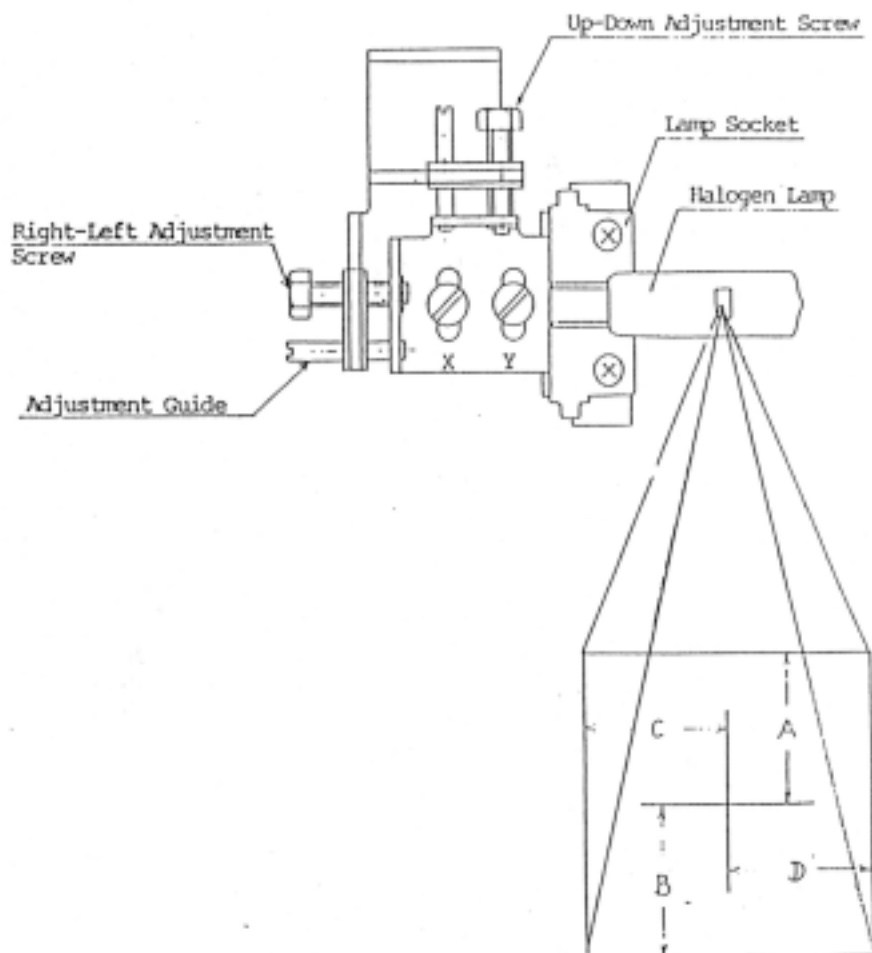
1. Do not fail to use within the specified maximum tube voltage.
2. Do not use installing on those x-ray tubes which focal distances are different from the ones specified.
3. If lamp replacement became necessary, do after the inside temperature decreased sufficiently.
4. Never fail to use the same type of lamp as specified.
5. Do not touch on the projection lamp, plastic mirror and front acrylic plate except when it became necessary to do so.
6. In case lamp was illuminated successively 5 times or so, keep it off for about 2 minutes till next operation for cooling purpose.

SECTION III. INSTRUCTIONS FOR MAIN ADJUSTMENT DEVICES

Lamp Replacement and Adjustment Method of Lamp Filament Position

1. For replacement of lamp, first remove the lamp cover, then remove the screen plate of lamp house, but never move the front acrylic plate.
2. Make sure first that the lamp surface temperature sufficiently decreased, and pull lamp out of the socket.
3. Wrap over the replacement lamp surface with a soft cloth or the like so as not to allow a finger to touch on the surface, and insert the lamp into the lamp socket so that the lamp pins will reach to the utmost depth of the lamp socket, then install the screen plate of lamp house.
4. After the replacement work, illuminate the lamp by pushing lamp timer, and measure if the centering cross mark is in the center of light field.
5. If the centering cross mark should be drifted from the center, adjust the lamp filament position as follows (see the drawing of next page).

- 1) Measure A size and B size:
In case A size was larger, loosen the Locking Screws(X & Y) and turn the Up-Down Adjustment Screw to left. In case B size was larger, turn the Adjustment Screw to right.
- 2) Measure C size and D size:
In case C size was larger, turn Right-Left Adjustment Screw to left. In case D size was larger, turn this Adjustment Screw to right.
- 3) At the position where A & B and C & D of light field became equal to each other lock lamp position by fastening firm the Locking Screws (X & Y).

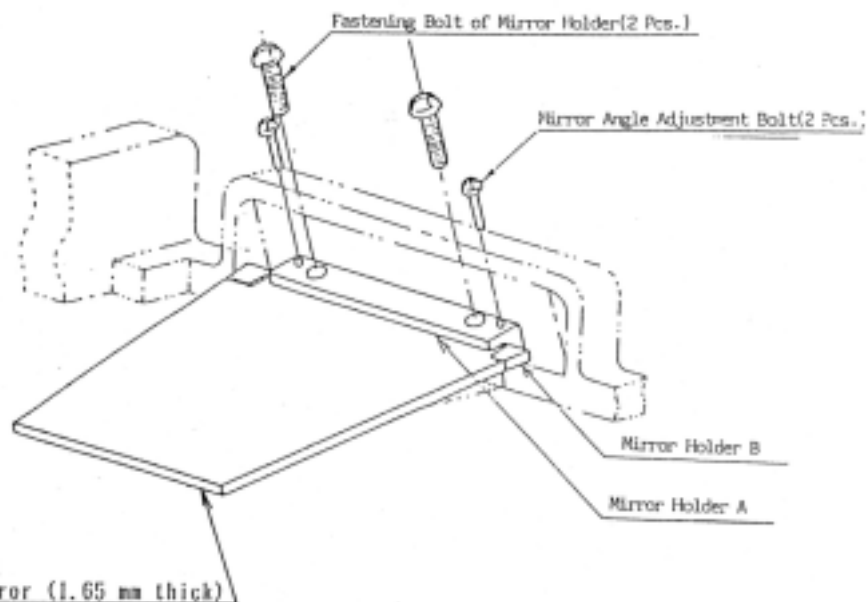


Alignment Check and Adjustment Method

1. This collimator is designed and factory adjusted to comply with Performance Requirement when it was correctly installed as specified in this manual, so far as the x-ray tube focus (target) position is correctly aligned with the center of the x-ray tube window.
However, the misalignment of light field with x-ray field can be checked and adjusted, as follows, if there might be a possibility that the misalignment might exceed 2 % of SID due to the Off-Center of tube focus position and or if check of misalignment was required.
2. Prepare a fluorescent paper on which the center and a field size are marked (e.g., a center cross mark and 125 mm x 125 mm, or 250 mm x 250 mm, or 350 mm x 350 mm).
3. Place the fluorescent paper on a flat surface so that it becomes perpendicular to the center line of light beam. Illuminate collimator lamp and align the center of fluorescent paper with the center cross mark of light field, at SID 100 cm, then collimate to the size marked on the fluorescent paper.
4. Make a longest possible x-ray exposure (if fluoroscopic condition is not available) and observe if the x-ray field is aligned with light field. If there'd be a noticeable misalignment (entire field is usually drifted to one direction due to the off-center of tube focus position), adjust the entire collimator position as below.
 - 1) Keep collimator mounted on x-ray tube, and a little loosen 4 pcs. of Rotation Stopper Bolts (see drawing in "Installation Method"), then loosen 4 pcs. of Ring Adjustment Bolts.
 - 2) Make x-ray exposure again and confirm that x-ray field is aligned with the field size marked on the fluorescent paper (if necessary, collimate x-ray field to the marked field size).
Illuminate collimator lamp and align the light field size to the x-ray field size by adjusting the collimator position.
At the position where it was aligned, fasten the Ring Adjustment Bolts and also fix the Rotation Stopper Bolts.
 - 3) If there'd be still a noticeable misalignment after above work and if there'd be a need to further adjust, the alignment can be adjusted by moving the lamp position as described in "Lamp Replacement and Adjustment Method of Lamp Filament Position".
 - 4) In case of alignment check with a radiographed film, prepare a film cassette a little larger than the field size, illuminate lamp timer, measure the light field edges and mark them on the film cassette with a fuse wire or the like, then make a radiography and measure the misalignment on the developed film.
The said mark with a fuse wire etc. will be placed so that it appears on the developed film even when x-ray field was smaller than light field.
The radiography will be made under minimum required condition.
If the misalignment measured on the radiographed film should exceed 2 % of SID as required by Performance Standard, further adjustment of alignment can be made in the same manner as above described.

Plastic Mirror Replacement Method

1. For replacement of plastic mirror, first remove the front acrylic plate, and open collimator shutters to the maximum positions in both of longitude and latitude.
2. Remove the installation screws of mirror holder (2 pcs.) and mirror holder A. Then, remove the plastic mirror with mirror holder B that is binded to the mirror.
3. Install the replacement plastic mirror fastened with mirror holder A, then temporarily fix the front acrylic plate.
4. Place a thin paper in front of the acrylic plate, then illuminate the lamp and gradually collimate the light field in both of longitude and latitude. At the position where the centering cross mark was aligned with the center of light field, lock the front acrylic plate with its 2 fastening screws.



SECTION IV. MAINTENANCE

1. Make a cleaning, every 3 months, of the front acrylic plate, collimator case and lamp surface. If a finger touched on the lamp surface, wipe out the finger print.
2. The plastic mirror will be replaced at any time if it was broken.
3. Make sure, before every use, that the lamp is illuminated when pushed the lamp timer.
4. Periodically check and make certain that warning label has not been defaced or worn so as to be illegible.

Compliance Maintenance Schedule

1. Conduct Illuminance Test, once a year and whenever lamp was replaced, to make certain that the average illuminance of light field at SID 100 cm is 180 lux or more.

If the measured illuminance was less than 180 lux, check the line voltage and line current to the lamp, and when necessary, replace the lamp to a new one, then again make sure that the illuminance is not less than 180 lux.

Note: The replacement lamp must be Philips Type 7158 Halogen Lamp, rated 24 V/150 W or an equivalent Halogen Lamp of the same rating that meets the international standard (of same filament size and shape).

2. Make sure, whenever lamp was replaced, that the centering cross mark of collimator complies with the center of light field. If it is drifted from the center of light field, adjust the lamp filament position till both the center comply with each other.
For adjustment method, see "Lamp Replacement and Adjustment Method of Lamp Filament Position" in Section III of this manual.
3. Check once a year and whenever lamp was replaced, and make certain that the contrast ratio of light field is 3.5:1 or more at SID 100 cm.
4. Check once a year and whenever lamp was replaced, and make certain the misalignment of light field with x-ray field is within 2 % of SID.
If the misalignment should be more than 2 % of SID, adjust it to within 2 % of SID. For the adjustment method, see "Alignment Check and Adjustment Method" in this manual.

CIRCUIT DIAGRAM

